the small systems journal

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FUTURE COMPUTERS?



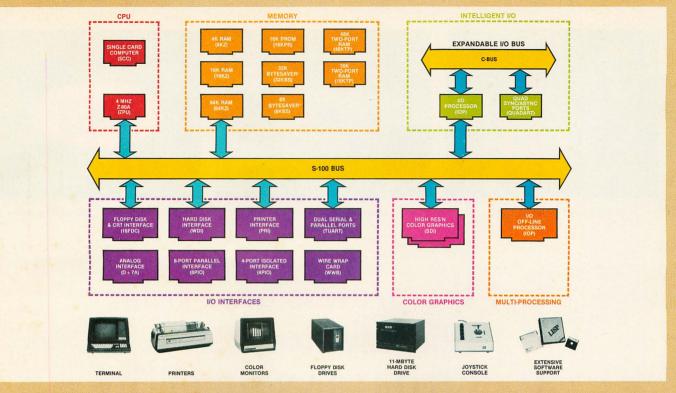
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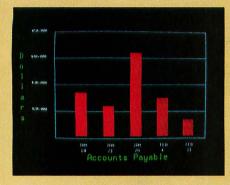


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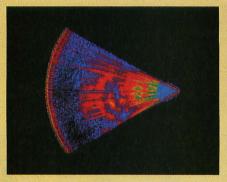
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Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

The SDI then maps computer display memory content onto a convenient color monitor to give high-quality, high-resolution displays (756 H x 482 V pixels).

When we say the SDI results in a highquality professional display, we mean you can't get higher resolution than this system offers in an NTSC-conforming display.

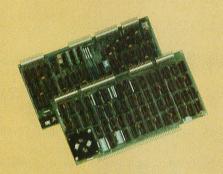
The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283



Model SDI High-Resolution Color Graphics Interface

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The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

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The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.



In The Queue

Volume 6, Number 4 April 1981

Features

20 Recurrence in Numerical Analysis by James J Davidson / Recurrence can be used to simplify the calculation of Bessel functions.

36 Build a Low-Cost Logic Analyzer by Steve Ciarcia / Turn your computer into a powerful diagnostic tool.

64 A-L BYTE Guide to The National Computer Conference and Chicago / Up-to-date information on the conference, the city, and much more.

G6 Digital Minicassette Controller by James Kahn / Use an intelligent peripheral controller to lighten the load on your computer system.

102 Programming the Game of Go by Jonathan K Millen / Even though Go is much harder than chess, a microcomputer Go program can produce surprisingly good play.

122 Build Your Own Turing Machine by James Willis / Three different practical versions of this theoretical tool produce the same output.

150 A Closer Look at the TI Speak & Spell by Peter Vernon / The author expands on Michael Rigsby's September 1980 BYTE article.

218 An Introduction to Data Compression by Harold Corbin / Information can be transmitted and stored using fewer data bits by appropriate techniques.

252 Build an Intercomputer Data Link by Mike Wingfield / Using this software, systems based on the 6800 microprocessor can communicate with other systems.

290 Three-Dimensional Computer Graphics, Part 2 by Franklin C Crow / Software to display solid objects without hidden lines and surfaces.

348 PADDLES: Interfacing with Modular Breadboards by Roger J Combs and Paul Field / Designing and implementing breadboard circuits is greatly eased with the use of these standardized modules.

Reviews

46 The MicroAce Computer by Delmar Searls
94 A Reformatter for CP/M and IBM Floppy
Disks by John Lehman
188 Three Versions of APL by Gregg Williams

Nucleus

- 6 Editorial: Future Trends in Personal Computing
- 10, 302 BYTE's Bugs
- 12 Letters

32, 34 Programming Quickies: Apple Name-Address; A Graphic Execution Display

98, 304, 310, 314 Technical Forum: MicroShakespeare Revisited or Kilobard; An ADM-3 Emulator for the Hazeltine 1500; Challenger Writes on Comprint; On the Use of Fourier Transforms to Explore Biological Rhythms

148 System Notes: A Relocatable Bootstrap for the Tarbell Disk Controller

158 Clubs and Newsletters

186 Cartoon

212 BYTELINES

328 Ask BYTE

332 Event Queue

338 Books Received

344 Software Received

345 BYTE's Bits

359 What's New?

414 Unclassified Ads

415 BOMB, BOMB Results

416 Reader Service

RUTF



Page 36



Page 46



Page 186



Page 302



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In This Iss

"Future Computers" is our cover theme this month and the subject of the editorial. Before you write to comment on our cover's "unusual" design approach (created by artist Robert Tinney), keep in mind the proximity of April

Elsewhere in this issue we describe Steve Ciarcia's latest project, a low-cost logic analyzer, and tell how to build your own Turing machine. Other articles include: a follow-up to our earlier review of the Sinclair computer, this time a description of the MicroAce kit version; a reformatter for CPIM and IBMformat floppy disks; a closer look at the TI Speak & Spell; a fascinating review of three different APL packages for the patient (but eager) APL fans in our audience; details about data compression; all about intercomputer data links and the game of Go; and the conclusion of an article from last month about 3-D computer graphics.

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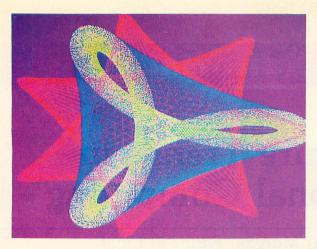
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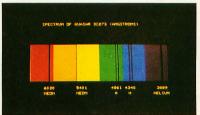
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BYTE, Product Review



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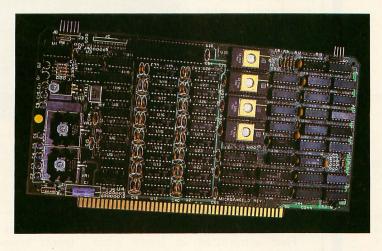
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Editorial

Future Trends in Personal Computing

Chris Morgan, Editor in Chief

Future Computers—what will they be like?

Some exciting developments have been occurring in the industry lately that should give us some clues. I attended the Consumer Electronics Show in Las Vegas this past January, where Toshiba introduced what could be the most significant product of the year for the personal-computing market: a pocket-size flat-screen television set. While no specific mention was made of its possible use with a personal computer, it takes only a moment's thought to see the potential of this engineering marvel.

First introduced in Japan some months ago, the Toshiba television has a 4.1 by 3.1 cm $(1\frac{3}{5})$ by $1\frac{1}{5}$ inch) LCD (liquid-crystal display) screen housed in a case measuring 17.3 by 8.2 by 1.8 cm (6 1/5 by 3 1/5 by 7/10 inches)! It has only half the resolution of a standard CRT (cathode-ray tube) display, but its small size masks that fact effectively. Toshiba has also solved the problem of liquid-crystal "overhang," the slow-fade effect that plagues LCDs in electronic games. The response time of this particular design is fast enough to handle the 1/30 of a second television-frame refresh rate. Although the screen is dimmer than a CRT display (the im-



Photo 1: Toshiba's new pocket-size television prototype. A built-in zoom feature is available that enlarges any one of the four screen quadrants for close-up viewing. Photo by Stan Miastkowski.

age is formed from reflected rather than transmitted light), it has acceptable contrast and sharpness. The screen is fed by a bank of shift registers; it would be an easy task to display computer graphics and characters on it.

The Toshiba flatscreen unit is still in the prototype phase and probably not be available for a year or so, retailing for approximately \$600. I predict that within two years the market will be flooded with portable computers having built-in screens of every size and shape.

Sony has introduced a new electronic "typewriter" that fits in a briefcase and lets you enter, store, and edit up to 200 pages of text using a built-in microcassette recorder. Text is displayed on a one-line liquid-crystal display. Combine such a device with a flat-screen multiline video display and you have a very attractive concept, indeed.

Another Sony breakthrough is a new miniature floppy-disk system (see photo 3, page 10). Each disk measures 8.9 cm (3½ inches) in diameter and holds over 800,000 bytes! The disk resides in a rigid housing for protection. Sony plans to introduce the disk as part of a new, miniature word-processing system.

Percom Mini-Disk Drive Systems for TRS-80* Computers...

Now! Add-On and Add-In Mini-Disk Storage for your Model III.

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- Greater Storage Capacity: Available with either 40or 80-track drive mechanisms, Percom TFD mini-disk systems store more. A 40-track drive stores up to 180 Kbytes — formatted — on one side of a 5-inch diskette. An 80-track drive stores a whopping 364 Kbytes.
- 1.5 Mbyte On-line: The Percom drive controller (included with the initial drive) handles up to four drives. With four 80-track mini-disk drives you can access over 1.5 million bytes of on-line file data.

Moreover, the initial drive may be either an internal add-in drive or an external add-on drive. And whichever configuration you get, the initial drive kit comes complete with our advanced 4-drive controller, interconnecting cables, power supplies, installation hardware, a DOS and of course the drive mechanism itself.

- First Drive Includes DOS: OS-80[™], Percom's fast extendable BASIC-language disk operating system, is included on diskette when you purchase an initial drive kit. Originally called MicroDOS, OS-80 was favorably reviewed in the June 1980 issue of Creative Computing magazine.
- Works with Model III TRSDOS: Besides being fully hardware compatible, Percom's Model III 40-track drive systems may be operated with Tandy's Model III TRSDOS — without any modifications whatsoever. And, TRSDOS may be easily upgraded with simple software patches for operating 80-track drives.

Percom TFD add-on drives start at only \$399. Model III Drive kits start at only \$749.95.

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The DOUBLER includes a TRSDOS*-like

double-density disk operating system called DBLDOS™ We also offer a double-density Model I version of OS-80 as well as DOUBLEZAP programs for modifying NEWDOS/80 and VTOS 4.0† for DOUBLER compatibility.

Of course you don't have to upgrade your computer for double-density operation to use Percom mini-disk drive systems. In single-density operation, our TRS-80* Model I compatible 40-track drives store 102 Kbytes of formatted data on one side of a diskette, and our 80-track drives store 205 Kbytes. By comparison, Tandy's standard drive for the Model I stores just 86

And like our Model III drives, Model I add-on drives are optionally available with "flippy" storage capability.

System Requirements:

Model III: 16-Kbyte system (min) and Model III BASIC. The second internal drive may be installed after the first internal drive kit is installed, and external drives #2, #3 and #4 may be added if either an internal or external first-drive kit has been installed. External drives #3 and #4 require an optional interconnecting cable. Model I: 16-Kbyte system (min), Level II BASIC, Expansion Interface, disk operating system and an interconnecting cable. For double-density storage, a Percom DOUBLER must be installed in the Expansion Interface and DBLDOS (comes with the DOUBLER) or other double-density DOS must be used. For single-density operation, a Percom SEPARATOR™ adapter, installed in the Expansion Interface, will virtually eliminate "CRC ERROR — TRACK LOCKED OUT" read errors. Prices and specifications subject to change without notice.



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Photo 2: The Osborne I personal computer. This new 64 K, Z80A machine has two floppy-disk drives and fits under an airline seat. Price: \$1795. Photo by Elliot Varner Smith.

Although no official word has come from the company, we have learned that it is developing a complete personal-computer system. Fujitsu and Seiko are also developing personal computers for the U.S. market.

New Trends in Portability: The Osborne I

This month Adam Osborne introduced a new personal computer, called the Osborne I, at the West Coast Computer Faire in San Francisco. Its features include: a Z80A processor; 64 K bytes of dynamic programmable memory (60 K bytes are available to the programmer; the remaining 4 K bytes are used by the display screen); IEEE and RS-232C interfaces; modem electronics; a 5-inch video monitor with 24 rows of 50 characters, upper- and lowercase, two display intensities, and underlining for all characters; two 5-inch single-density, single-sided floppy-disk drives; standard typewriter keyboard; 10-key numeric pad; two pockets for storing floppy disks; and the following software: the CP/M operating system, CBASIC, WordStar, Mailmerge, and a CP/M-compatible spread sheet program that resembles VisiCalc.

There are two particularly interesting points about this computer: (1) it will cost \$1795, and (2) it's portable! An optional battery pack will be sold with the unit. Also optional are a 9-inch monitor, an acoustic coupler, and double-density, double-sided floppy-disk drives. The \$1795 price tag (which includes all the software) is remarkably low. It remains to be seen if the company can turn a profit at this price. I recently had an opportunity to see the Osborne I in action. I was impressed with its compactness: it will fit under an airplane seat. (Adam



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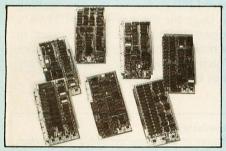
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Circle 6 on inquiry card. Micros for bigger ideas.

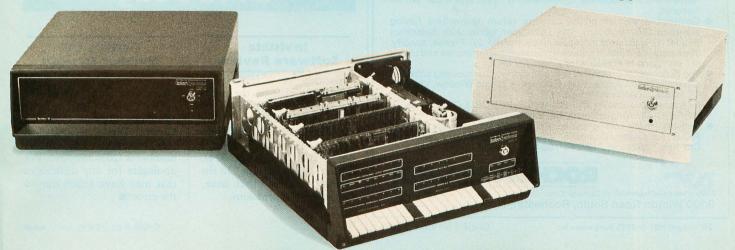




Photo 3: Sony's new 3½-inch floppy disk and drive. Each double-sided floppy disk can hold up to 875 K bytes of information, unformatted. The recording density is 1.47 times that of the 5-inch disk.

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Osborne is currently seeking approval from the FAA to operate the unit on board a plane.) One quibble: the screen may be too small for some people's taste. Consulting Editor Mark Dahmke is preparing a full test report on this computer for an upcoming issue of BYTE.

Update

We have received numerous requests for more information on the Microterminal described in the January editorial. We cannot divulge any more information at this time, but watch for a complete report coming soon.

Also in the works: full reports on the Commodore VIC-20 color computer; the TRS-80 color computer hires (high-resolution) graphics; a special issue on local networks; reviews of three LISP packages; the new spellingcorrection programs; Logo for the Apple II and TI 99/4; and our annual August language issue, this year on Smalltalk, one of the most exciting languages in the computer field today. Watch our upcoming editorials for further information about future computers.

The Carl Helmers Newsletter

Readers of recent issues of BYTE are probably aware that Carl Helmers, former Editorial Director of BYTE, is now working on projects outside of McGraw-Hill. One of Carl's new undertakings is the Carl Helmers Personal Computer Newsletter, which will cover the present state of personal computing, future developments in hardware and software, artificial intelligence, mass storage, and many other topics. The newsletter will contain no advertising, cost \$200 per year, and will appear monthly. Carl is also considering a free 'personal computer industry conference call," which would be made available via a toll-free 800 number if interest among subscribers is high enough. The setup would enable up to twenty people to participate in a regularly scheduled monthly "roundtable" discussion.

For more information about subscribing to the newsletter, write to North American Technology Inc, Strand Building, Suite 23, 174 Concord St, Peterborough, NH 03458, or call 603-924-6048. We wish Carl luck in his new venture...CM

BYTE's Bugs

Invisible **Software Review**

Because of a last-minute scheduling change, the product review by BYTE editor Gregg Williams, "The muSIMP/muMATH-79 Symbolic Math System" (November 1980 BYTE, page 324), did not appear on the "In the Queue" page for that issue. We regret the omission.

Getting the **Number Straight**

In the February 1981 BYTE, on page 345 of the "What's New?" section, the telephone number given for General Digital Corporation was incorrect. The correct number is (203) 289-7391. We apologize for any difficulties that may have arisen due to the error.

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Letters

Computers and Trees: The HHC Forest

I read Gregg Williams and Rick Meyer's article about the Panasonic/ Quasar hand-held computers (January 1981 BYTE, page 34), and I could hardly contain my excitement over the potential use for these devices in my field: forest measurements and statistics.

Forest inventory and survey work typically involves many man-hours in the forest collecting information on tree size, species, sawtimber quality and value, growth, etc. This information is normally hand-written on tally sheets in the field, and either hand-tabulated in an office or key-encoded for statistical summary and analysis by computer. Forest scientists and practicing foresters are continually looking for more economical methods of obtaining resource information at the level of precision required for complex management planning and decisionmaking.

The HHCs (hand-held computers) appear to have the capability of being used in the field as data-entry devices, thereby eliminating the need for subsequent keyencoding of hand-written information. With their alphanumeric capability, they should be able to store and manipulate descriptive text as well as numeric information. With suitable applications programs, I would think they are also capable of handling a fairly large repertoire of forestry problems (eg: compiling tables describing timber volumes by species, log grade, and size class; estimating stumpage values for timber sales, etc). For larger data-processing requirements, they could transmit their data, through the modem attachment, to a host computer. In short, I see in these devices a potential for greatly reducing the man-hours required for routine data-entry and processing applications in forestery.

George L Martin Jr Assistant Professor of Forest Biometry Department of Forestry College of Agricultural and Life Sciences University of Wisconsin 1630 Linden Dr Madison WI 53706

The advent of HHCs will be a boon to many who must perform data entry and sophisticated calculations in the field. Unfortunately, neither the price nor the availability date of the Panasonic/Quasar unit was announced at the CES (Consumer Electronics Show), as I had originally hoped. As an educated guess, I would place the price in the \$400 to \$650 range, with the units possibly being available as early as mid-1981....GW

Oddest Programming Language of Them All

In the December 1980 BYTE, Mr Daniel Weise presented a version of a self-reproducing program. (See "Thief-Reproduthing Programth," page 16.) The following version of the same fundamental algorithm is written in my favorite programming language—English:

Replace every occurrence of "x" in "x'x'." by "Replace every occurrence of 'x' in 'x "x".' by ".

Which executes as follows:

Unquote "x'x'." to obtain the form x "x".

Replace "x" by the quoted substitute to obtain x "Replace every occurrence of 'x' in 'x "x".' by ".

Replacing x by the unquoted substitute we obtain Replace every occurrence of "x" in "x'x'." by "Replace every occurrence of 'x' in 'x''x''.' by ".

The operations quote and unquote work as follows:

Quote text = "text*". Unquote "text*" = text.

where text* is a faithful copy of text, except for the replacement of each quote mark, single or double, by its complement. This transformation is idempotent. This is a time-honored syntactic device of English.

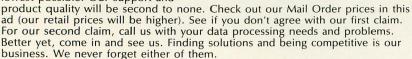
I leave it to you, dear reader, to judge the relative perspicuity of this English version and the LISP version provided by Mr Weise.

James P Corbett 24 Sheffield Lane Florence MA 01060

Readers should note that they may not be able to get this program to run on every model of the human brain-which is probably just as well, since once running, it would use up all available processing time and memory space....CPF

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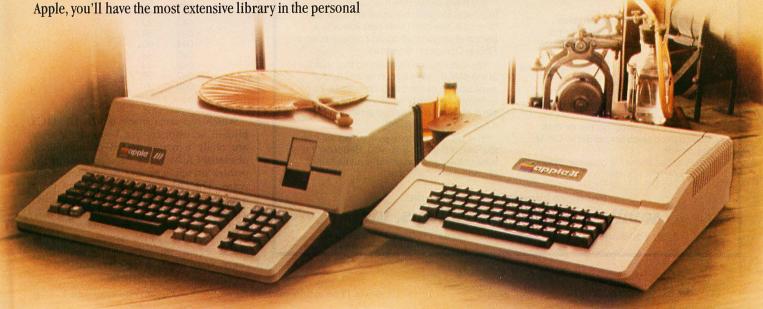
There's even a series of utility programs called the DOS Tool Kit that not only lets you design high-resolution graphic displays, but lets you work wonders with creative animation.

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Vive la Guerre

I have a few comments on Bruce Carbrey's article "A Pocket Computer? Sizing up the HP-41C." (See the December 1980 BYTE, page 244.) The article was very interesting, since I use both an HP-41C and a TI-59 frequently. Mr Carbrey did a comparison that I had planned but had never done.

On page 246, he states that storing a number in a register on a TI-59 requires three lines. This applied to the earlier SR-52, but only two lines are needed with a TI-59. Two is better than three, but the

one-line approach of the HP-41C is better. It makes editing a program without a printer much easier, especially since you don't have to remember key codes.

Mr Carbrey's benchmark test program does not, however, use the TI-59's strengths well. A major difference between the calculators is that both label and absolute addressing exist on the TI-59, while the HP-41C uses only labels. Since the HP-41C program is compiled, it is not penalized. Using absolute addressing in the TI-59 program cuts run time by 3 seconds and saves a step.

Listing 1 is a benchmark program that

uses the TI-59's parenthesis feature. This seemed especially apt considering Hewlett-Packard's and Texas Instruments' battle over Reverse Polish Notation vs Algebraic Operating System. My program is 10 steps shorter, uses 4 data registers, and runs in 33 seconds. This improved performance is achieved by reducing the number of relatively slow memory arithmetic operations and utilizing the TI-59's stack. (Also note that the correct answer in Mr Carbrey's table 1, on page 254, is \$17553.30, not \$17533.30.)

Much has been made of the HP-41C's plug-in accessories, but I wonder if they are really a major design change. They obviously follow TI's development of the printer attachment and Solid State Software. The HP printer has excellent print quality and features, but it is very slow. The Bar-Code reading "Wand" is the only significant advance in my opinion.

The capacities of the two calculators are about equal in my experience. Most users want both a printer and a card

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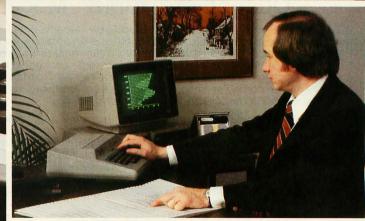
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reader, so only two memory modules can be added. Thus, a maximum of 830 program lines is available without data registers in practical applications, and this limit is quickly reduced. Even allowing for the HP-41C's greater storage efficiency (I find a 50% improvement over the TI-59), the HP-41C is only marginally better.

The lack of a TI response to the HP-41C threat mystifies me. Although users were surveyed last spring, no new product has appeared. The discounts being offered on TI's "59" calculators clearly suggest that something is coming soon, but it has been a year since the HP-41C's introduction.

Perhaps the pocket computers from Radio creased capacity at lower cost in the programmable-calculator marketing wars. I

G John Garner 319 Blue Haven Rd Dollard des Ormeaux, PQ, Canada

Shack and Sharp threw a wrench into the works. TI has always played a game of inawait TI's next entry with great anticipation. Users have profited immensely from the battles between Hewlett-Packard and Texas Instruments in this market. (Take out your old calculator and try using it now.) Vive la guerre!!!



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Patent Pending

Compoliution

Steve Ciarcia's article "Electromagnetic Interference" (January 1981 BYTE, page 48) is a very good and long-overdue summary of the electronic noise-pollution problem. Many radio engineers have been fighting the battle against the plastic computer box and the poorly designed digital boards that dominate the industry. We are ready for some stiff regulations regarding fundamentals, such as simple metallic shielding and grounding practices, so that the rest of the world can continue to use RF (radio-frequency) communications.

One omission in Mr Ciarcia's article is the reference to a state-of-the-art handbook or text for more comprehensive information on the subject. One of the best comes from Bell Laboratories, in Henry W Ott's book Noise Reduction Techniques in Electronic Systems (New York: John Wiley & Sons Inc, 1976).

R W Burhans Ohio University Avionics Engineering Center Athens OH 45701

This omission was caught and rectified. See "BYTE's Bits" March 1981 BYTE, page 314, for additional reading material. Also, see I N Demas's review in the September 1980 BYTE, page 311....GW

Well-Rounded Machine

We at Hewlett-Packard were very pleased to see Brain Hayes's excellent article on the HP-41C calculator. (See "The HP-41C: A Literate Calculator?", January 1981 BYTE, page 118.) He did make some statements that deserve clarification, however. In particular:

There is something absurd about the world's fanciest calculator not being able to give results accurate to more than seven or eight decimal places.

The example he used was the $(\sqrt{2})^2$ computation, which is a good illustration of a common misunderstanding about computer arithmetic. When calculating $\sqrt{2}$, the 41C works internally with 13 digits and then rounds correctly to 10 digits. This helps to insure the accuracy of the displayed result. But this result is still not really $\sqrt{2}$, merely the best representation possible on this, or any other, 10-digit machine: 1.414213562.

At this point, the calculator does not know where this number came from: it could be a previous result, or it could have been entered exactly as such through

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Letters.

the keyboard. Squaring this number correctly and rounding again yields 1.999999999. Any 10-digit calculator that does otherwise is either doing "funny arithmetic," or else is not telling you everything it knows. But the 41C has lived up to its claim: each calculation was performed correctly to 10 digits. Also, and at least as important, the behavior of the calculator is utterly predictable and repeatable.

A calculator is a tool, and, like any tool, it has its limitations. These limitations must be understood if the tool is to be used properly. The point is this: there exist sequences of calculations that will generate errors of *any* magnitude on *any* finite-precision arithmetic machine. Keeping this in mind, the "world's fanciest calculator," the HP-41C, is a tremendously powerful tool indeed.

Steve Abell Research and Development Engineer Hewlett Packard Company Corvallis Division 1000 NE Circle Blvd Corvallis OR 97330

MicroAce: More Power to Sinclair

I disagree with John McCallum's statement in "The Sinclair Research ZX80" (see the January 1981 BYTE, page 94) that by building the kit version "you will not save any money." My MicroAce cost a mere \$150—a savings of 25% over the price of a ZX80. It was easy to build, although the instructions were not nearly as elaborate as Heathkit's.

The MicroAce has room for two more programmable-memory integrated circuits than the ZX80. The increase to 2 K bytes almost triples the possible program length (portions of the first 1 K bytes are used for "housekeeping"). This expanded capacity gives you a much more usable computer. Its unique design means that you can store as much information as other systems that use 3 K to 4 K bytes.

I couldn't afford \$500 or more for a computer, but, for about \$175 (kit plus memory chips), I have learned quite a bit and gained much enjoyment while doing

John R Mullen 8518 Terrang Ct Rockford IL 61111

The MicroAce kit is reviewed by Delmar Searls on page 46 of this issue.

Calling Z8000

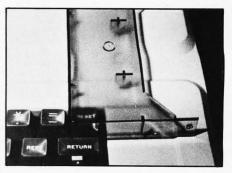
The "BYTELINES" section of the January 1981 BYTE (page 200) contained

an item saying that Microsoft proposed a standard set of calling conventions specifying parameter-passing and register usage for the Z8000 microprocessor. It was actually Zilog Inc, inventor of the Z8000, that established the conventions. Zilog announced the Z8000 standards at last year's WESCON show in Anaheim, California. The announcement contained the statement that the conventions "have thus far been adopted by Microsoft and are under consideration by several other companies."

Thank you, BYTE, for letting me set the record straight by pointing out that Zilog originated the Z8000 calling conventions that were subsequently adopted by Microsoft.

Bruce Weiner Product Marketing Manager Zilog Inc 10460 Bubb Rd Cupertino CA 95014

Why Didn't We Think....



I always look forward to the latest issue of BYTE, as I am sure many others do. I would like to pass along this suggestion to my fellow readers who use an Apple II computer. It is my solution to the well-known "accidental RESET" problem that plagues users of that machine.

Manauba Sakuta, MD 6324 Wilryan Ave Edina MN 55435

December Adventure

BYTE's "Product Reviews" of games in the December 1980 issue were absolutely perfect. There are too many bad programs on the market; being able to see a picture of the display (along with a description of how the game is played) is a big help.

I noticed that BYTE didn't continue this policy in the January 1981 issue—I realize that you can't have seven game reviews in every issue, but it would be nice....

Thanks.

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Recurrence in Numerical Analysis

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Although Taylor's series are the most universally useful method of computing higher mathematical functions, they do have their drawbacks. In particular, many functions have representations only in the form of alternating series. This can cause great difficulty in maintaining accuracy if large arguments are required. Often, so many significant digits are lost in the process of computation that the results are, at best, useless. At worst, if you do not suspect that gross inaccuracies are occurring, you may make severe engineering mistakes.

If the various remedies such as argument scaling are ineffectual in improving accuracy, the only recourse is to seek alternate methods of computation. Of those alternatives, recurrence relations have the widest applicability.

What's a Recurrence Relation?

Various functions have the mathematical property that if you know two consecutive values, you can use those to find a third. This process can be repeated to find a fourth from the second and third, and so on. Of course, you need to pick the right pair to start from, but if you do, you can get to any value you want.

The simplest illustration of a recurrence relation is the Fibonacci series. This is a series of special numbers known in medieval times to Leonardo of Pisa, surnamed Fibonacci (1175-1230). Fibonacci numbers are found in botany and other natural sciences, as well as in certain mathematical theories of aesthetics. They are interesting in their own right, and there is at least one society devoted to study of their mathematical properties.

The Fibonacci series proceeds in the following fashion:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, . . .

Each term is obtained by adding the two previous terms. As a formula, the series can be expressed as:

 $a_{n+2} = a_{n+1} + a_n$

where the initial terms must be specified as 0 and 1. Once you get started, it is obvious that you can keep going indefinitely using the same formula. It is not even necessary to begin at the beginning. If you know the thirteenth and fourteenth terms, for instance, you can find the fifteenth by adding them together.

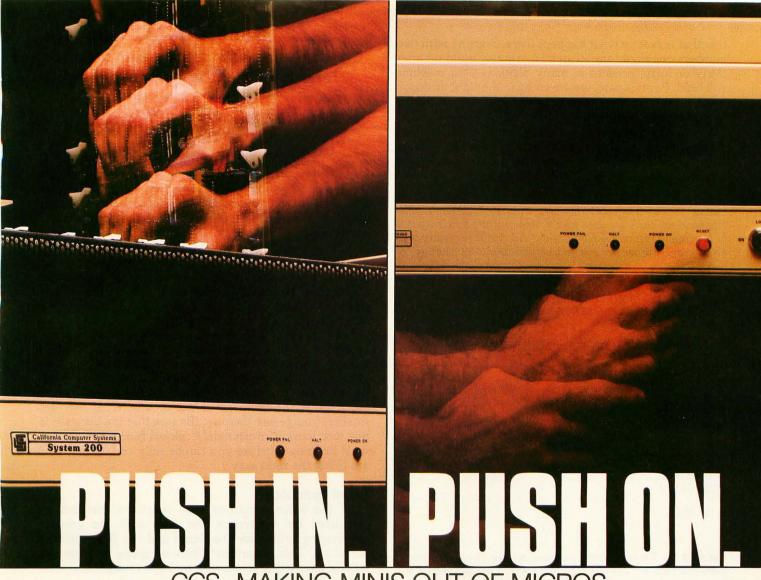
Programming this recurrence relation is not going to be much of a chore. The important thing to keep in mind is that three values must exist within the computer simultaneously: the n and (n+1) terms, and the sum of these two, which is the value being calculated. Then, after the value is found, it must be slid into the (n+1) position, with that one being slid into the n position. This sliding process is the only tricky part because it must be done in the proper order, and it is the heart of all recurrence programming.

Listing 1 shows how simple the job is. After initialization, the FOR...NEXT loop handles the calculation in 6 lines. The new term is calculated in line 160 and printed in line 170. The sliding process is done in lines 180 and 190. Note that A1 must be slid into A0 before A2 is slid into A1; otherwise, A1 will be lost. That, in principle, is all there is to programming recurrence relations.

Forward and Backward Recurrence

Recurrence relations have a property that on first acquaintance seems absolutely incredible: if you go in the "right" direction, you increase the number of significant digits in your answer with every new term. This means that in certain cases you can start out with a completely arbitrary guess and, if you go long enough, end up with eight or nine significant digits in your final result! On the other hand, if you go in the "wrong" direction, you lose digits with each iteration and end up with garbage.

There is nothing at all mysterious about this property. If you think about the Fibonacci series, you will realize



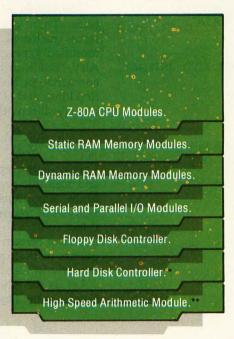
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that that is exactly what happens there. Starting with two numbers one digit long (0 and 1), you can build up after thirty or forty terms to as many digits as your machine will hold. For this case, we are going in the right direction because the answers get progressively larger as we calculate each new term.

In this case also, we are moving in the direction of increasing index, n. This is called forward recurrence. If we were to start out with a high-order pair of terms and calculate down towards zero, that would be called

Listing 1: The Fibonacci numbers through recurrence. The Fibonacci numbers are used here to demonstrate how easy it is to program a recurrence relationship. All that is necessary is to keep proper order in the calculation and the shifting of variables.

```
0010 REM
0020 REM *** FIBONACCI NUMBERS
    REM *** BY RECURRENCE RELATION.
0030
0040 REM
0100 INPUT "HOW MANY FIBONACCI NUMBERS".N
0110 A0=0
0120 PRINT AO
0130 A1=1
0140 PRINT A1
0150 FOR I = 1 TO N - 2
0160 A2=A1+A0
0170 PRINT A2
0180 A0=A1
0190 A1 = A2
0200 NEXT I
0210 END
```

Listing 2: A Taylor's series program for the Bessel functions. Lines 160 thru 190 calculate the first term. (Line 160 should not be necessary, but many BASICs insist on executing a FOR...NEXT loop at least once, regardless of index and target.) This program is not recommended if the argument will ever exceed about five or ten, depending on your BASIC.

```
0010
      REM
      REM *** BESSEL FUNCTIONS, FIRST KIND, INTEGER
0020
      ORDER
0030
     REM *** BY TAYLOR'S SERIES.
0040
     REM
0100 INPUT "ARGUMENT", XO
0110 INPUT "ORDER", N
0120 \quad X = X0/2
0130 X2 = X \times X
0140 S=0
0150 T = 1
0160 IF N = 0 THEN 200
0170 FOR I = 1 TO N
0180 T = X/I * T
0190 NEXT I
0200 FOR I=1 TO 999
0210 S = S + T
0220 T = -X2/I/(N+I)*T
0230 IF S<>S+T THEN NEXT I
0240
     PRINT S
0250 END
```

Of the various mathematical functions that can be calculated by recurrence, the ones with the greatest engineering utility are the Bessel functions.

backward recurrence. For the Fibonacci series, backward recurrence is "wrong" (because you lose significant digits) and forward recurrence is "right" (because you gain them), but for some other functions the reverse is true.

Putting it another way, if you lose digits going one way, it is because (and only because) you are subtracting nearly equal large numbers. Avoidance of that situation is one of the cardinal principles of numerical calculation. In this case, avoidance consists simply of going in the opposite direction, in which case you are adding the numbers instead of subtracting them.

But how do you know which direction to go in? Very simply, look in a mathematics handbook. If that fails, and you have no knowledge of function behavior to guide you, trial and error is a solution. Set the program up for forward recurrence (which usually is easier) and see whether the terms get larger or smaller. If they get smaller, you guessed wrong. (Be sure that the decrease is not just local. Unfortunately, global function behavior must be known before you can be fully certain that you are going the right way.)

Bessel Functions

Of the various mathematical functions that can be calculated by recurrence, the ones with the greatest engineering utility are the Bessel and the Bessel-related functions. This is fortunate because many of these are strictly alternating series with no hope of argument scaling, and large arguments always seem to be the ones of greatest interest.

The family of Bessel functions includes many variations. There are the first, second, and third kinds; integer, fractional, and noninteger orders; and regular and modified types. The related functions include Kelvin, Airy, and Ricatti-Bessel. For now, though, we will be concerned exclusively with regular Bessel functions of the first kind, and of integer order. These arise as solutions of Bessel's differential equation:

$$x^{2} \frac{d^{2}y}{dx^{2}} + x \frac{dy}{dx} + (x^{2} - n^{2})y = 0$$

This equation appears in a wide variety of engineering and scientific problems, such as heat transfer and membrane vibrations. It also shows up indirectly in the analysis of frequency-modulated signals. Any time cylindrical coordinates are used in analysis, Bessel's equation is almost certain to be involved somewhere. As a consequence of that fact, Bessel functions are also called (particularly in German) cylinder functions.

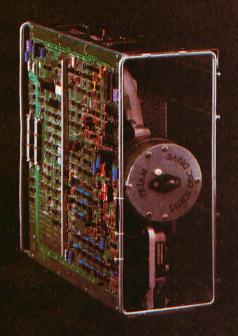
Let us see where the problem lies in computing these functions by Taylor's series. The Taylor's expansion is:

$$J_n(x) = \left(\frac{x}{2}\right)^2 \sum_{c=0}^{\infty} \left(\frac{-x^2}{4}\right)^i \times \left(\frac{1}{i!(n+i)!}\right)$$

This is clearly a strictly alternating series, and the critical

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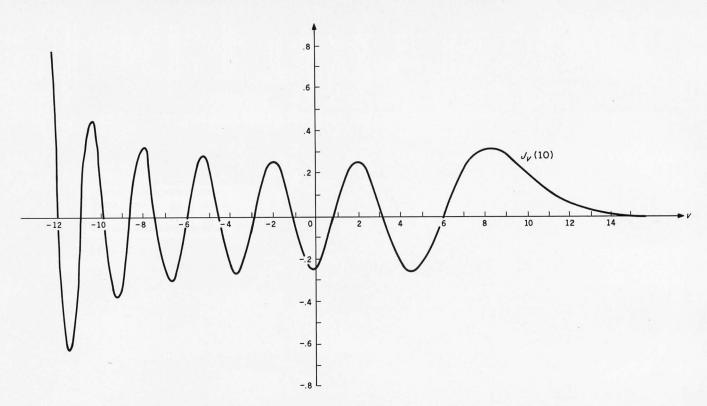


Figure 1: The Bessel function of argument 10 and variable order v. When progamming a recurrence relation, information such as this is needed to determine whether to use backward or forward recurrence. Since the function goes to zero for large orders (values of v), we conclude that we need to use backward recurrence to achieve good accuracy. The Bessel function behaves similarly for other arguments: as soon as the order (v) exceeds the argument (x), the function rapidly declines to zero.



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argument occurs at x = 2. But it is rare that one is satisfied with values that small.

Listing 2 is the program for this series. Keep in mind that the magnitude of the Bessel function can never exceed unity, and see where your machine starts to bomb. If you have double precision, you may want to see how much difference it makes. Recognize, too, that a range of 10^{38} can be a real limitation. For x=100, the largest term nearly reaches 10^{41} . Depending on your BASIC, a maximum argument of five to ten is recommended.

Bessel Recurrence Relation

Now to recurrence. The relation we will use is:

$$J_{n+1}(x) = (2n/x)J_n(x) - J_{n-1}(x)$$

and the first thing we need to know is which direction to go. This is a recurrence in order, not argument, so the question is whether the function increases or decreases as the order gets larger and the argument stays constant. Figure 1 (from the National Bureau of Standards handbook) answers this clearly. At large positive arguments, the function heads toward zero. This means that, when we want to calculate $J_n(x)$ for a given n, we must calculate higher-order values of J(x) and use the recurrence formula to calculate down to order n.

The next problem is where to start. This is quite an involved question, and, unfortunately, there are no established answers.

Let us suppose we want to calculate $J_8(22)$. We have to start someplace above eight, but where, and with what? If we knew, for example, $J_{18}(22)$ by calculation, we would probably just as easily know $J_8(22)$ by calculation and

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would not need to use recurrence. We will make an arbitrary guess (using it and zero as the two numbers needed to start recurrence) and let the virtues of "right" recurrence provide our significant digits.

However, while it is true that recurrence can provide increased accuracy, this is true only relative to the initial guess, which was arbitrary. This means the result we get may be highly precise but completely inaccurate. What we look for, then, is some way of normalizing, or adjusting, the result. Perhaps somewhere in the process, or in the final answer, there is a clue to what the right output should be. If so, that clue can be used to give us the correct value.

Normalizing Sum

The solution lies in one nice formula:

$$1 = J_0(x) + 2J_2(x) + 2J_4(x) + 2J_6(x) + \dots$$

If we simply double each even term as we calculate it and add them all together, then subtract one zeroth term (because it is not doubled in the formula), we should get unity. If we do not (and we will not), divide the recurrence result by this sum and out comes a closer approximation to the correct answer.

This does mean, however, that every calculation will always have to proceed all the way to zero order. The formula also tells us how far up we must start: at an order high enough that its contribution to the sum will be negligible.

The full process goes like this: you begin by choosing an argument at random, then finding the highest order that makes a difference in the total sum. If the total sum is greater than 1.00, divide the beginning argument by this number and repeat the process. The final result should be a beginning argument and an order high enough so that two conditions are true: first, that the next higher-order term does not contribute significantly to the sum; and second, that the sum is approximately equal to 1.00.

You will find that the starting point depends both on the argument and the order of the answer you desire. Larger arguments always require higher starting points, as do higher orders. But the relationship is not simple, and no single equation will fit all points exactly. If the equation must err (and it must), it is best that it do so on the high side, although it should not be too far on the high side.

If the starting point is too low, the normalizing sum is inaccurate, degrading the answer. If it is too high, execution time becomes excessive and you run the risk of exceeding your machine's range. (The sum can grow very quickly.) Note, however, that it is the normalizing sum, not the recurrence calculation, that is the main source of trouble. Recurrence starts with an arbitrary guess anyway and goes in the "right" direction (backward), so accuracy is not an issue here (with one important exception that will be explained later).

Programming all of this—except for the equation derivation—really is not too difficult, but it is messy and time-consuming. Fortunately, it has been gone through by various mathematicians, and formulas do exist for finding the starting order. The results listed will vary, though, depending on the number of significant digits in the particular machine they were developed for.

Table 1 gives the raw data rounded to the next higher even integer of the starting order necessary for ten-place accuracy. This information was compiled by Samuel G Allen of New York on an SR-56 pocket calculator. From

	i	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
n	0 15 17 20 25 30 35 40 45 50 560 65 70 75 80 85 90 95		24 28 30 36 40 44 48 54 58 64 68 72 76 82 96 100 104	102	36 36 38 42 44 48 54 58 62 76 80 84 90 94 100 104 108	38 38 44 46 48 56 60 64 68 82 86 90 96 100 110	50 50 52 54 58 66 70 76 80 84 88 92 98 102 106 110	56 56 58 60 64 68 72 86 88 94 98 104 106 112	104 108	70 70 70 74 78 80 84 88 92 98 102 106 110	76 76 78 80 82 86 90 94 98 104 108 112 116	86 86 86 86 88 92 96 100 106 110 114 118	88 88 90 92 94 98 102 106 110 116 120	94 94 94 96 100 104 106 110 116 120	98 98 102 104 106 108 112 116 120	104 104 106 108 112 116 118 122	110 110 112 116 118 122 126	116 116 118 120 124 126	122 122 122 126 128	128 128 130 132	134	138	
	i	0.1	0.5	1	2	3	4	5	6	7	8	9	10	11	12								
n	0 1 2 4 6 8 10	6 8 10 12 12 14	8 10 10 12 12 14 16	10 10 12 12 14 16 18	14 14 14 14 14 16 18	16 16 16 18 18 20	18 18 18 18 18 20 22	20 20 20 20 20 22 22	22 22 22 22 22 22 22 24	24 24 24 24 24 24 26	26 26 26 26 26 26 26	26 26 26 26 26 26 26	28 28 28 28 28 28 28 28	30 30 30 30 30 30	32 32 32 32 32 32 32								
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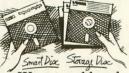
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Listing 3: Generating Bessel functions by recurrence. This one is slower than Taylor's series for small arguments, but is vastly more accurate for large ones. Within the accuracy range of a machine, no limit has been found on maximum order or argument.

0010 REM

0020 REM *** BESSEL FUNCTIONS, FIRST KIND, INTEGER ORDER

0030 REM *** BY RECURRENCE RELATION.

0040 REM

0100 INPUT "ARGUMENT", XO

0110 INPUT "ORDER", N

0120 X = X0

0130 IF ABS(X) < 1.E - 10 THEN X = 1.E - 10

0140 Y = X

0150 IF N > X THEN Y = N

0160 N9 = INT(Y + 3*SQR(X) + 9)

0170 J9=0

0180 J8 = 1.E - 30

0190 S = 0

0200 FOR I = N9 TO 0 STEP -1

0210 J7 = 2*I/X*J8 - J9

0220 J9=J8

0230 J8 = J7

0240 IF INT(I/2) = I/2 THEN S = S + 2*J9

0250 IF I = N THEN J = J9

0260 NEXT I

0270 S = S - J9

0280 J=J/S

0290 PRINT J

0300 END

the data, he derived a fairly simple equation which errs conservatively by about ten percent in the region N=4X. The equation is as follows:

 $N9 = int(max(N,X) + 3\sqrt{X} + 9)$

which is implemented in lines 140 thru 160 of listing 3.

Program Comments

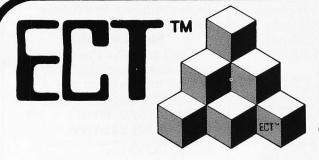
If you have followed the discussion to this point, the program in listing 3 should be straightforward. Lines 140 thru 160 calculate the starting order, and lines 170 thru 190 do the initialization. Note that the arbitrary guess for J8 $(J_n(x))$ is 1.0×10^{-30} . It is chosen small (and can be much smaller if your range goes to 10^{-99}), so that large arguments can be accommodated without overflowing the normalizing sum. J9 $(J_{n+1}(x))$ is initialized to zero, which reflects the assumption that the next higher term is too small to be significant.

The recurrence loop (lines 200 thru 260) includes the normalizing sum at line 240. Line 250 picks out the particular order you specified and stores it as variable J.

After exiting from the loop, line 270 subtracts a zeroorder term from the sum, and line 280 divides the chosen

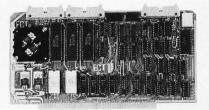
value by S to normalize it properly.

One fact has not yet been mentioned: the recurrence relation involves a division by x, so that x=0 causes an error message. But this is a perfectly legitimate argument at any order, so line 130 assigns a small value instead. It cannot be too small, though, or overflow will occur rapidly because of that division by x.



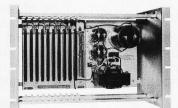
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1601 Orangewood Ave. / Orange, Calif. 92668 (714) 633-4460 TWX / TELEX: 678 401 TAB IRIN See us at the sixth Computer Faire, booth 1526, San Francisco April 3-5 Altering this program to give a complete array of Bessel functions of various orders for a given argument is easy. Simply define an array of dimension N+1 and start storing values when the variable I becomes equal to N. At the end, each value must be divided by S.

You will find that execution time for this program is quite long. For small x, the Taylor's series is much faster and therefore may be preferred for arguments that are guaranteed restricted. When in doubt, use the recurrence method (listing 3).

Negative Orders

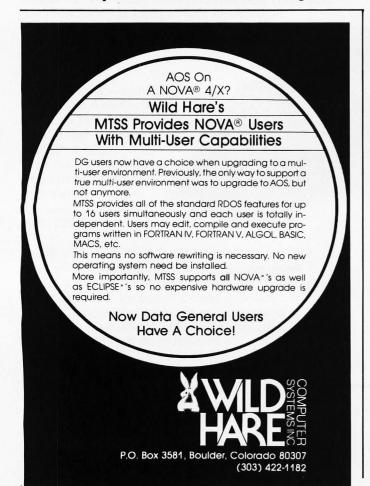
Note from figure 1 that the behavior at negative orders is very different than that of positive orders. So, instead of trying to adapt listing 3 to handle negative N, use the absolute value of N for N and transform the output by the relationship:

$$J_{-n}(x) = (-1)^n \times J_n(x)$$

How Accurate Is It?

There is only one practical way to check accuracy on a routine like this: compare the results against known values in a published table. But that creates a problem because available tables give out before the program does. The massive compilation by the staff of the Harvard Computation Laboratory (Harvard: 1947) goes up to x=100 and n=135.

The most sensitive test, though, is to check in the region of the zeros at various orders. The Bessel functions look like damped sine or cosine waves, crossing zero at



The most sensitive test is to check in the region of the zeros of the function.

intervals that look as though they might be periodic. (However, they aren't and the exact locations of the zeros is of considerable interest to mathematicians.) Obviously, if you put in an argument that is supposed to be at a zero of the function, you expect to get a result of zero. This is unlikely for two reasons:

• The locations of the zeros are transcendental numbers and cannot be specified exactly. The theoretical result, then, should not be exactly zero.

• Backward recurrence is "right" only when the function increases as you proceed in that direction. But at a zero, the function suddenly nosedives down (see figure 1). Here, $(2n/x) \times J_n(x)$ is supposed to equal $J_{n+1}(x)$, so their difference is zero. This is subtraction of nearly equal large numbers, which usually results in a small truncation error.

For the above reasons, all errors and inaccuracies accumulate at the zeros. In particular, truncation errors show up flagrantly here. Not only does truncation cause the output to be nonzero, it actually translates the apparent location of the zero to a lower value. The truncation is not really bad (it usually affects only the last digit), but those interested in the mathematical properties of Bessel functions should be aware that this bias does exist.

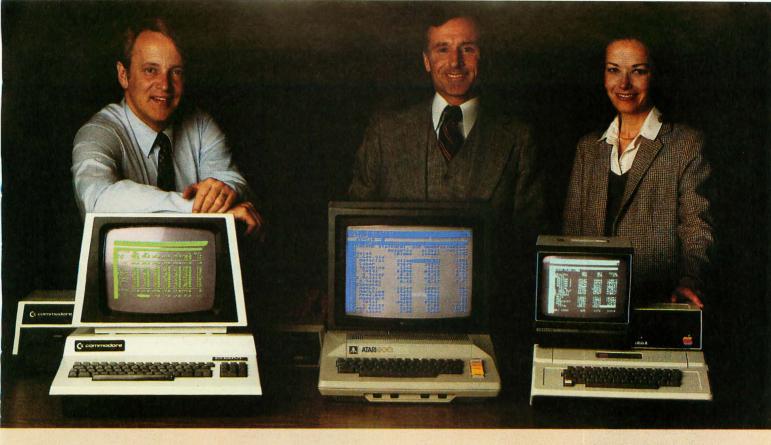
With that background, we can state that the accuracy of the program of listing 3 on a nine-digit truncating BASIC is seven to eight decimal digits. Note that I said decimal digits, not significant digits. As far as I can determine, the seventh digit after the decimal point is good to within one count anyplace, including zeros. Away from the zeros, the eighth digit appears good to within one count. This includes any x or n up to one hundred, based on spot and systematic checks against the Harvard tables.

Using the Royal Society tables of zeros, further checks can be made under worst-case conditions. For example, the forty-eighth zero of order 19 occurs at x=178.846699. The actual output there is 7.6×10^{-8} , which will cause the seventh digit to be off by one count. Worse errors may be possible, but this one is the largest I found.

Other BASICs with fewer digits should have similar properties: about a two-digit loss as long as the range is not exceeded by the normalizing sum. For engineering use, this should be entirely adequate.

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- 3. Olver, F W J (editor). Royal Society Mathematical Tables, Volume 7: Bessel Functions Part III, Zeros and Associated Values. New York: Cambridge University Press, 1960.



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Programming Quickies

Apple Name-Address

Gary Stotts, 10390 Owens Cr, Broomfield CO 80020

Name-Address is a program that will store up to 100 names, addresses, and telephone numbers. It is written for the Apple personal computer and requires one disk drive. The program is organized as a binary tree so that names can be entered in any order and stored in alphabetical order. A larger number of names and addresses can be stored by changing the DIM statements in lines 30 thru 90.

The program first asks if there is an address file. Next the menu appears as follows:

- 1 Add a Name
- 2 List a Name
- 3 List All Names
- 4 Change a Name
- 5 End

Listing 1: Name-Address—a program for the Apple II that will store up to 100 entries, as shown here. More entries can be stored by changing the DIM statements in lines 30 thru 90.

The required entries to add or change a name-address

record are the name, the street address, the city-state-zip, and the telephone number. To list any one address, enter the name. The name must be entered as last name first

with no commas. Option 5, "END", will always create a

REM BINARY TREE NAME/ADDRESS FILE
REM AUTHOR GARY A STOTTS
DIM N*(100): REM NAME ARRAY
DIM A*(100): REM DODRESS ARRAYS
DIM B*(100)
DIM LX(100): REM LEFT LINK ARRAY
DIM RX(100): REM RIGHT LINK ARRAY
DIM RX(100): REM PHONE # ARRAY
DIM \$X(50): REM STACK ARRAY
DEM \$X(50): REM STACK ARRAY
DEM \$X(50): REM STACK ARRAY
D* = CLH**
CALL - 936: INPUT "15 THERE ON ADDRESS FILE (Y/N) ";Y*
IF Y* = "N" THEN 200
PRINT D*:"READ NAMADR"
INPUT E
FOR I = 1 TO E
INPUT N*(1): INPUT A*(1): INPUT B*(1): INPUT P*(1): INPUT LX(1): INPUT RX(1)
REXT PRINT DS
CALL - 936: PRINT TAB(7): "NAME/ADDRESS PROGRAM": PRINT
PRINT "1 - ADD A NAME"
PRINT "2 - LIST A NAME"
PRINT "3 - LIST ALL NAMES"
PRINT "3 - LIST ALL NAMES"
PRINT "4 - CHANGE A NAME"
PRINT "5 - END"
PRINT "1 - HIPLT " ENTER YOUR SELECTION "; AS: M1 - VAL (AS)
IF M1 < 1 OR M1 > 5 THEN 260
ON M1 GOSUB 320.720.930.1120.1340
GOTO
DEED

250 PRINT : INPUT " ENTER YOUR SELECTION ":A\$:H1 - VAL
270 IF HI (1 OR HI) 5 THEN 250
280 ON MI GOSUB 320,720,930,1120,1340
280 GDTO 290
300 REH
310 REM ADD A NAME SUBROUTINE
320 CALL - 936: PRINT TAB(7):"ADD NAME RECORD": PRINT
330 E = E + 1: REM FIRST EMPTY POSITION IN LIST
340 I - 1: REM START SEARCH AT RODT
350 INPUT "ENTER NAME ":NI\$
360 IF LEN (NI\$) < 1 THEN 350
370 INPUT "ENTER STREET ADDRESS ":A1\$
380 IF LEN (A1\$) < 1 THEN 370
390 INPUT "ENTER STREET ADDRESS ":A1\$
380 IF LEN (A1\$) < 1 THEN 370
390 INPUT "ENTER STREET ADDRESS ":A1\$
380 IF LEN (A1\$) < 1 THEN 370
390 INPUT "ENTER THEN 370
390 INPUT "ENTER PHONE NUMBER ":PI\$
400 IF LEN (B1\$) < 1 THEN 370
410 INPUT "ENTER PHONE NUMBER ":C\$
410 IF NI\$ < > N\$(1) THEN 370
420 IF NI\$ < N\$(1) THEN 380
430 IF NI\$ < N\$(1) THEN 380
440 IF NI\$ < N\$(1) THEN 380
440 IF NI\$ < N\$(1) THEN 380
440 IF NI\$ < N\$(1) THEN 380
450 PRINT "DUPLICATE NAME"
460 INPUT "ENTER C TO CONTINUE ":C\$
470 RETURN
480 REM IF LEFT LINK NOT NULL, SEARCH LEFT BRANCH
480 IF LX(1) < > O THEN I = LX(1): GOTO 430
500 REM HANG NEW LEFT LINK ON PRIOR
501 DX(1) > E
520 N\$(2) = N1\$: REM FILL NEW RECORD
530 A\$(2) = 81\$
530 A\$(2) = 81\$
530 A\$(2) = 11\$
530 RETURN
590 RETURN
790 REM LIST A NAME SUBROUTINE
790 PRINT SHIPL "ENTER NAME TO LIST ":NI\$
690 PRINT SHIPL "ENTER NAME TO LIST ":NI

new name-address file.■

IF L%(I) < > 0 THEN I = L%(I); GOTO 760 REM SEARCH RIGHT IF R%(I) < > 0 THEN I = R%(I); GOTO 760 REM PRINT "NAME NOT FOUND" RETURN RETURN

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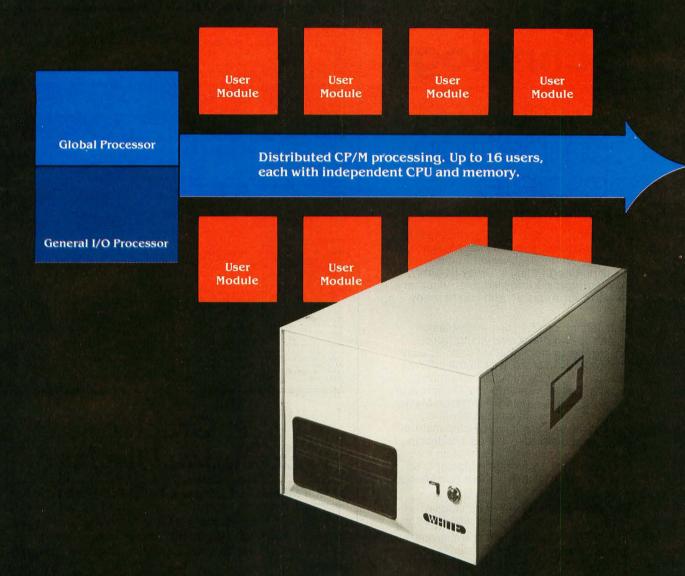
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Listing 1 continued on page 34



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Look for a single user CP/M® system that expands to multiuser configurations economically.

Look for independent 6 MHz Z80B-based User Modules with 64K of RAM memory, each module with a port to the user terminal capable of handling baud rates of up to 38K under program selection. Look for high-speed block data transfers from user modules to the Global Processor for disk storage. That way, CP/M programs run independently for each user. Fast. And each users's station acts just like the fastest standalone system — no delays, no waiting for other users.

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That's part of how you tell if it's a White Computer. There's a lot more. Here's a number and address for more information.

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Programming Quickies.

Listing 1 continued:

```
200 REM LIST ALL NAMES SUBROUTINE
930 P = 1:L1 = 0:T = 0: CALL - 936
940 T = T + 1
950 S%(T) = P: REM PUSH STACK
960 IF P < > 0 THEN P - L%(P): GOTO 940
970 T = T - 1
980 IF T < = 0 THEN INPUT "ENTER C TO CONTINUE ":C*: RETURN : REM ALL NAME FOUND
980 P - S%(T): REM POP STACK
1000 PRINT N*(P): REM PRINT NAME
1010 PRINT A*(P)
1020 PRINT B*(P)
1030 PRINT P*(P)
1040 PRINT
1050 L1 = L1 + 5
        1040 PRINT
1050 LI = LI + 5
1060 IF LI = 20 THEN LI = 0: INPUT "ENTER C TO CONTINUE ":C$
1070 T - T - I
1080 P - RX(P): REM CHECK FOR RIGHT LINK
1090 GOTO 940
1110 PEM CHANGE AN ADDRESS
                                                  GOTO 940
REM
CHANGE AN ADDRESS
CALL - 936: PRINT TAB( 7); "CHANGE A NAME/ADDRESS": PRINT
INPUT "ENTER NAME TO CHANGE ":N1$
IF LEN (N15) < 1 THEN 1120
    1120 CALL -935: PRINT TASK 7): "CHANGE A NAME.
1130 IMPUT "ENTER NAME TO CHONGE "NI$
1140 IF LEN (NI$) < 1 THEN 1120
1150 I = 1
1160 IF NI$ > N$(I) THEN 1310
1170 IF NI$ < > N$(I) THEN 1310
1180 PRINT "OLD "FA$(I)
1290 IF LEN (N$(I)) < 1 THEN 1190
1200 IF LEN (N$(I)) < 1 THEN 1190
1201 PRINT "OLD "EN$(I)
1200 INPUT "NEW "FB$(I)
1200 INPUT NEW INPUT NE
                                                          PRINT E
                                                          FOR I = 1 TO E
PRINT N$(I): PRINT A$(I): PRINT B$(I): PRINT P$(I): PRINT L%(I): PRINT R%(I)
          1400 NEXT
1410 PRINT D#;"CLOSE"
1420 END
```

A Graphic **Execution Display**

R B Minton, 8617 E Stearn Lake Dr, Tucson AZ 85730

I wrote a program for my Ohio Scientific Superboard to compute artificial satellite orbits and noted it ran slower and slower as time and the number of orbits progressed.

It occurred to me that I could graphically display how fast the program was executing and find out where it was slowing down by adding some extra code. Every 20 lines or so, I inserted K9=K9+1:GOSUB 2000, and then at the end:

```
2000 S9 = 54244
2010 POKE S9+K9,48+K9
2020 FOR Z=1 TO 30:NEXT Z
2030 POKE S9+K9.32
2040 IF K9=9 THEN K9=0
2050 RETURN
```

This flashes the numbers 1 thru 9 from left to right on the bottom row of the video screen every time the main portion of the program loops. You can easily note the delay between certain numbers; this helps to pinpoint where the program is spending most of its time. The troublesome area or line can be further narrowed down by adding more GOSUBs, or by moving those from the faster part to the slower part. (Be sure that there are nine GOSUBs and that each is executed only once within the loop.)

This method alerted me to a poorly written line of code I would have otherwise never suspected.

*Apple II is a trade name of Apple Computer, Inc.



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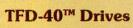
You can operate these drives in ordinary singledensity format using TRSDOS*, Percom OS-80™ or any other single-density operating system.

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Free software patch with drive purchase. This software patch, called PATCH PAK,1" upgrades TRSDOS* for single-density operation with improved 40- and 77-track drives.

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Ciarcia's Circuit Cellar

Build a Low-Cost Logic Analyzer

Steve Ciarcia POB 582 Glastonbury CT 06033

The Digital Age has spawned a variety of electronic troubleshooting aids, including logic probes, integrated-circuit test clips, multi-trace oscilloscopes, and logic analyzers. All are useful, up to a point, but it is important to know when to use a particular test instrument and how much you can depend on it.

If the logic states of signal lines were the only information needed, a simple voltage measurement would suffice in digital troubleshooting. But timing, rather than absolute voltage level, is the more important consideration in digital systems. Most digital systems operate by setting discrete logic conditions on bus lines and then strobing that data through the system at the occurrence of edges of specific clock pulses. A system operates correctly only if all the

parallel states are set correctly at a specific instant in time. The system fails if any single logic state is in error at any clock time during program execution.

Photo 1: One frequently used test instrument is a direct-reading state indicator. The sixteen indicators are transistor-driven incandescent lamps or LEDs (light-emitting diodes). The indicator panel is attached to a "chip-clip" connector so that the logic states on any TTL (transistor-transistor logic) or LS (low-power Schottky-diode-clamped) TTL dual in-line package can be read while the circuit is energized. The display is most valid for static conditions.

The first special digital instrument was the logic probe. A schematic diagram of a typical logic probe is shown in figure 1. This device accurately indicates the logic state on

LED (light-emitting diode) indicators at any selected point in a circuit. However, it is a static device and will not follow rapidly clocked digital logic other than to indicate general activity. Even when the concept is expanded to include fourteen or sixteen separate indicators on the probe (as shown in photo 1), effective use still depends on stopping the system clock (or slowing it substantially) to examine static logic states. Unfortunately, stopping the clock changes the dynamics of circuit operation and may, in many instances, mask the true cause of problems.

More frequently, digital-logic errors are dynamic and occur during clock-state transitions. The errors are often due to timing problems associated with the propagation of signals through the circuit or with miscuing of

multiplexed components. Because the logic state at clock transitions often

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determines either proper operation or failure, a more suitable test instrument would be one that provides the operator with a view of all logic activity coincident with the transition of the clock.

To most people this sounds like a job for a multi-trace oscilloscope with its sweep triggered from the system clock. An oscilloscope can in many instances be of value, but unless it is an expensive storage-tube scope, fast system-clock rates can make viewing difficult. Also, viewing two signals with respect to each other in real time is of little help when the error occurs intermittently and involves more signals than can be viewed simultaneously.

What Is a Logic Analyzer?

One solution to the digital-troubleshooting dilemma is called a logic analyzer. This is an instrument that displays a "truth table" of the activity of the digital circuit being tested under actual operating conditions. After you have selected a key combination of input signals, called a *trigger* or *sync word*, and activated the analyzer, it stores all signal-input logic states for a specific number of

system-clock transitions. Depending upon the sophistication of the particular unit, many commercial logic analyzers can accommodate 32 or more inputs and store up to 256 clock cycles before and after the trigger event.

A logic analyzer acts like an electronic time machine.

In effect, a logic analyzer acts like an electronic time machine. When sequentially displayed in the order it was acquired, the stored data can be used to form state tables or timing diagrams of the circuit's operation.

For example, a logic analyzer might be used to troubleshoot a malfunctioning microcomputer I/O (input/output) port that keeps receiving consistent but wrong data. You don't know whether the error is caused by the wrong data being sent to the output register or by an incorrect address signal strobing the register at the

wrong time (try troubleshooting this kind of problem with just an oscilloscope). You can find out by connecting the logic analyzer to the address and data buses of the microcomputer.

Set the trigger-word switches to produce a trigger pulse when the address bus contains the I/O port address. When the trigger pulse occurs, you can examine the logic states on the data bus with the analyzer to see what value was being loaded into the port register at the occurrence of the trigger pulse, as well as those states following the pulse. It is like having an 8- to 32-channel oscilloscope with the display frozen in time on a specific clock cycle.

Commercial logic analyzers are generally stand-alone instruments with integral video-monitor or oscilloscope displays. They can present stored data in a variety of ways. A data-domain analyzer ordinarily displays logic states as lists of 1s and 0s. The listings are sequential and in either binary, octal, or hexadecimal format. This display method is particularly helpful when you are debugging address-bus problems. In such cases, data is most easily read as

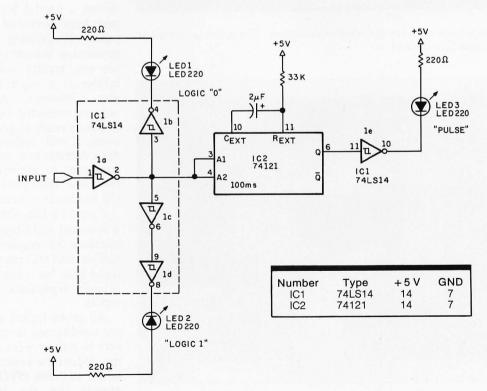


Figure 1: A simple logic probe that uses two integrated circuits. When a logic-0 signal voltage is applied to the input, the "logic 0" LED will light. When a logic-1 signal voltage is applied to the input, the "logic 1" LED indicator will light. If the input oscillates between the 0 and 1 states, the "Pulse" LED indicator will also light.

4-digit hexadecimal values.

For hardware troubleshooting, a time-domain analyzer is preferred. This unit presents the stored data in timing-diagram format. The result appears like the display of an 8- or 16-channel oscilloscope. The vertical scale has a high-voltage value that represents a logic 1 and a low-voltage value that represents a logic 0. The

data signals are plotted with respect to each other and can be displayed as a function of actual time.

A third data format is the *mapped* mode. Essentially, the display screen is divided into an x, y coordinate system, and data points are plotted as dots on the screen. In some units, vectors between dots connect successive data points so that it is easier for an

operator to trace sequential activity in the device under test. The process of interpreting this kind of display is essentially one of recognizing a "good" pattern and identifying wild vectors. Presumably, a properly operating program will have a repeatable pattern. Any discrepancies will show up as an extra dot or "wild vector."

The various types of logic-analyzer display formats are shown in figure 2 on page 40.

Regardless of the display format, all logic analyzers share a common internal structure. Generally, they incorporate the subsystems outlined in the block diagram of figure 3. All logic analyzers have some form of input conditioning, trigger-word selection and comparison, memory, and display (LEDs, oscilloscope, or raster-display tube, etc). The combination of capabilities is usually a function of price, which can range from \$2500 to \$10,000.

A Low-Cost Logic Analyzer

Obviously, we cannot hope to construct a logic analyzer that is equivalent to an \$8500 Hewlett-Packard unit. However, we can design a special logic analyzer as a peripheral device of a personal computer. By utilizing the display and processing power of the computer, we can greatly enhance the capabilities of a relatively simple hardware interface. Also, for those readers interested in the concept but not quite ready to grab their soldering irons, I will outline a method that demonstrates how to use your present computer to perform logic-analyzer functions totally in software. First, the hardware approach.

Figure 4 is the schematic diagram of a low-cost eight-input logic-analyzer interface that requires only one and a half parallel I/O ports (9 output and 6 input bits) for complete operation. It is easily expandable to 16 or even 32 inputs.

All probe inputs and clock signals are conditioned through Schmitt triggers to reduce noise and false triggering. When the sync word, set on external switches (SW1 through SW8), appears on the input lines, the analyzer automatically collects and stores 16 sequential words repre-



Photo 2: The prototype logic analyzer described in this article. The switches on the left are for setting the trigger (sync) word.

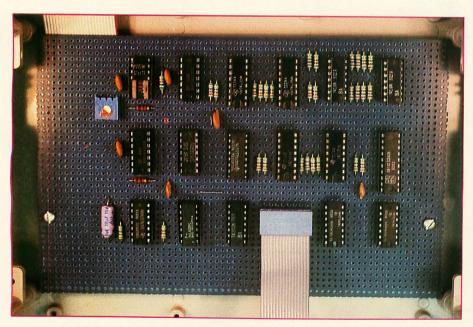


Photo 3: *Inside the box of photo 2 is the circuit of the analyzer as shown schematically in figure 4. Seventeen integrated circuits are used.*

senting input status at the instant of either an internal or external clock signal (usually the system clock). It can operate on either edge of the clock pulse and store data at frequencies as fast as 5 MHz. The prototype interface is shown in photo 2.

Unlike commercial logic analyzers, this unit has no integral CRT (cathode-ray tube) display: it has eight externally controlled LEDs. It depends instead upon the computer to display the list of stored data. After the interface has taken sixteen samples, it sends a Scan Complete signal to the computer. A computer program sets the Read/Write line to the Read mode and sets a 4-bit address to access the contents of the 16-word scratch-pad memory. As the 4-bit address is incremented, the appropriate 8-bit output is placed on the analyzer's data-output lines from the scratch-pad memory and is stored by the computer. In addition, as the computer reads the scratch-pad memory, the contents of each location are displayed on eight LEDs. If the addresses are changed slowly, or are otherwise physically set, the 16 stored words can be viewed directly without a special display program.

Once the data has been acquired by the computer, a format-and-display program lists the values on the computer's display in binary, octal, or hexadecimal format, simulating a commercial analyzer display. To gather an additional 16 words, the computer program merely sets the Read/Write line to the Write mode and toggles the Sample Enable line. The BASIC program in listing 1 on page 43 exercises the interface and displays the output shown in listing 2.

Inside the Interface

The analyzer hardware (shown in photo 3) has an interface consisting of seventeen integrated circuits. Input signals are fed through IC1 and IC2, which are hex Schmitt-trigger inverters. Photo 4 shows typical test connections. These conditioned outputs are in turn buffered and gated through to the memory section by IC3, a type-74LS240 8-input bus driver. The output of this driver is compared to eight preset switches through two 74L85 4-bit comparators (IC7 and IC8). (Trigger-word initiation is disabled by setting all switches to the logic-1 state. Storage will com-

mence on the first clock pulse after Sample Enable.) If the switch settings and data input are equal, a pulse is generated which stores the current input data. The first word stored is usually the sync word (assuming that the trigger word and external clockpulse edge are synchronous).

On the trailing edge of the WE (memory-write-enable) pulse, the 4-bit memory-address counter IC9 is incremented. Data will be stored again at the occurrence of the next edge (positive or negative as selected) of the clock pulse.

Text continued on page 42

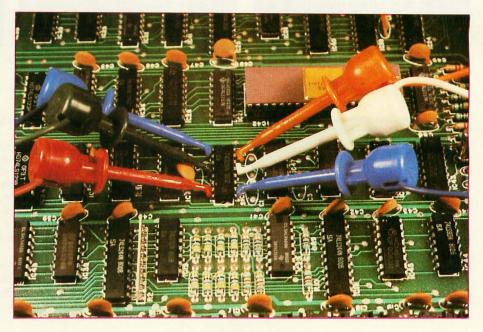


Photo 4: The analyzer is intended for use while a circuit is in dynamic operation. Connection to the circuit can be done with the "chip-clip" method shown in photo 1, or by using separate test probes. The latter is more versatile. The circuit shown under test is the Disk-80 expansion interface from last month's Circuit Cellar.

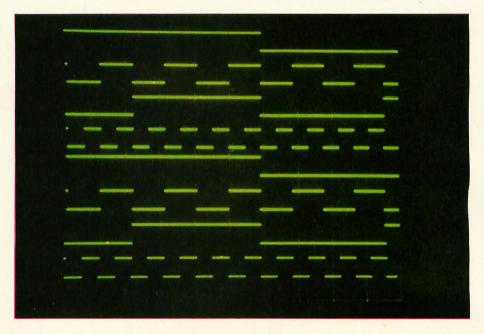
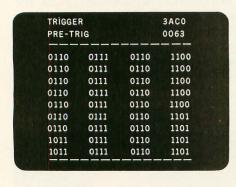
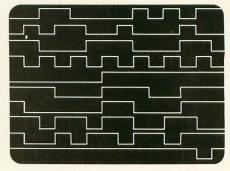


Photo 5: When the circuit of figure 5 (on page 42) is attached to the logic analyzer, a data-domain display can be converted to a time-domain display. Essentially nothing more than an eight-channel scope multiplexer, this circuit greatly expands the display potential of the average oscilloscope, as the photo demonstrates.









(2b)

(2c)

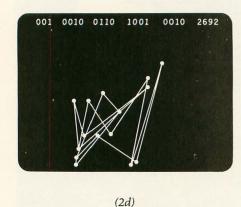


Figure 2: The data acquired by a logic analyzer can be displayed in various formats. The different types are:

(2a) The ones and zeros logic-state display. In this format, binary words are plotted against clock pulses in a matrix m bits wide by n clock pulses deep. This format is used most often where word flow or data sequence is of prime concern.

(2b) Same as 2a except that the data is listed in hexadecimal notation. Hexadecimal listings are most frequently used in logic analyzers specifically designed for microprocessor troubleshooting, where thirty-two to forty inputs are not uncommon.

(2c) The timing-diagram display. In the timing format, data words are plotted against time. This format is used most often for hardware troubleshooting to detect incorrect timing between signals.

(2d) Vector-display analyzer. In the vector-display format, data words define points on an x, y coordinate system. Usually, the data word is divided in half with a separate D/A converter attached to each segment. One output goes to the display's x input and the other goes to the y input.

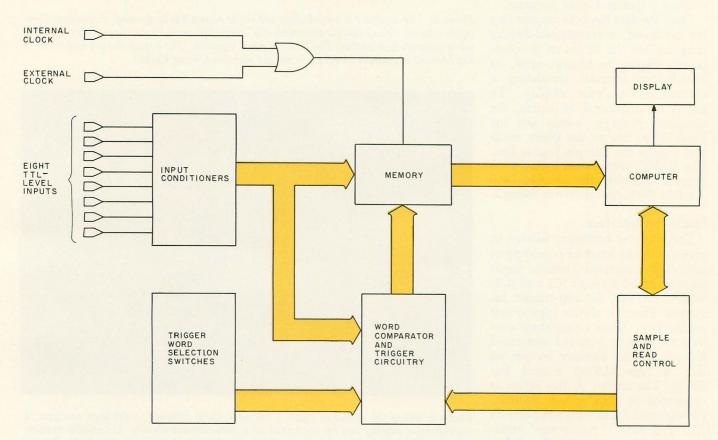


Figure 3: Basic block diagram of the simple logic analyzer. In this case, the block labeled "computer" refers to an externally attached personal computer. In commercial units, the computer and display are integral components of the logic analyzer.

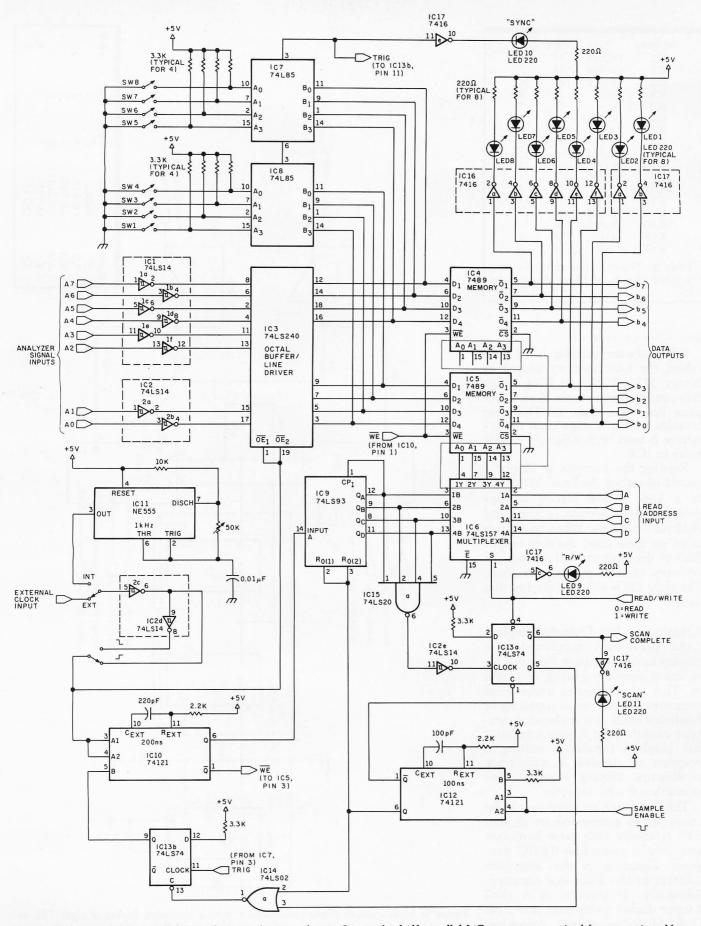


Figure 4: Schematic diagram of an eight-input logic analyzer. One and a half parallel I/O ports are required for operation. Note that the 74L85 integrated circuits used here have a different pinout specification from the 74L885. User connections are on the left; computer connections are on the right.

Number	Туре	+5 V	GND	
IC1	74LS14	14	7	
IC2	74LS14	14	7	
IC3	74LS240	20	10	
IC4	7489	16	8	
IC5	7489	16	8	
IC6	74LS157	16	8	
IC7	74L85	16	8	
IC8	74L85	16	8	
IC9	74LS93	5	10	
IC10	74121	14	7	
IC11	NE555	8	1	
IC12	74121	14	7	
IC13	74LS74	14	7	
IC14	74LS02	14	7	
IC15	74LS20	14	7	
IC16	7416	14	7	
IC17	7416	14	7	

Table 1: Power connections for integrated circuits of figure 4, on page 41.

Text continued from page 39:

When sixteen samples have been taken, the 4-bit memory address is binary 1111. IC13 and IC14 detect this condition and set the Scan Complete line to a logic 0. This also disables further storage until the interface is reset with a Sample Enable pulse to IC2.

Reading the contents is simply a matter of setting the Read/Write line to a logic 0 and placing an appropriate 4-bit address on the Read Address input lines. When an address is set on these lines, the data-output lines of the analyzer will contain the contents of that memory location. The eight LEDs will also display that value.

Creating a Time-Domain Display

As previously mentioned, the display format available from this interface is generally a listing of 1s and 0s. This is quite useful under most circumstances but not as appealing to hardware buffs as a timing-diagram-type output. Even if your computer has graphics capability, writing a program to simulate a multi-trace oscilloscope display requires considerable software expertise.

The logic-analyzer interface can be converted to a time-domain display with relatively little extra hardware and only a single-line BASIC program. Figure 5 is the schematic diagram of the additional circuitry. Essentially, it consists of a dual 4-input digital multiplexer and 2-bit D/A (digital-to-analog) converter, which offsets each of the four channels when displayed. In effect, it

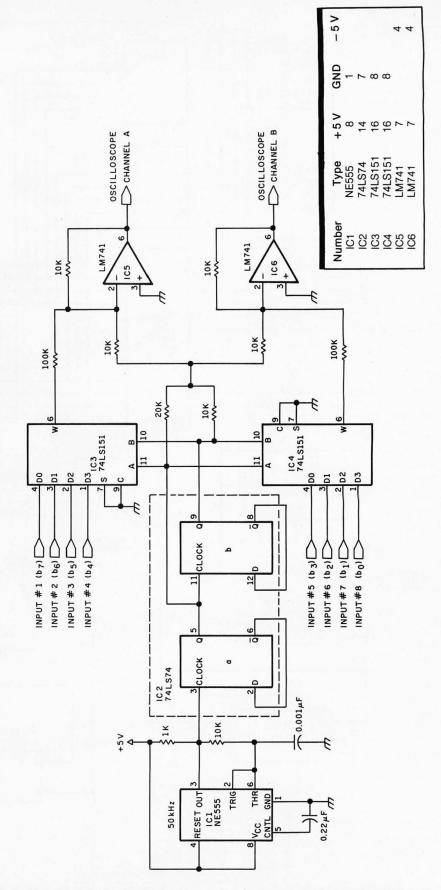


Figure 5: Eight-channel display multiplexer, which facilitates display of eight TTL inputs on a standard dual-trace oscilloscope. Its intended use is to convert the data-domain output from the circuit of figure 4 into a time-domain display on an oscilloscope.

allows a dual-trace oscilloscope to display eight channels simultaneously. Such a display appears in photo 5.

Conversion from data-domain to time-domain operation is not as difficult as it might seem. Consider the operation of the analyzer for a moment. Once the 16-word buffer is full, the data can be read out at any rate. If we cycle the read addresses very quickly, the outputs will form a repetitive pattern which can be easily viewed on an oscilloscope. The fast cycling can be accomplished using a 4-bit counter and oscillator source attached to the address-input lines or by using a simple program statement like:

100 FOR X = 0 TO 255:OUT 16,X: **NEXT X:GOTO 100**

Using a dual-trace oscilloscope, you can view two signals, or, with the circuit of figure 5, you can view all eight data channels simultaneously. Since there is no system clock to contend with and the pattern repeats every sixteen steps, triggering problems are reduced and the display is stationary. All other interface operations remain the same.

Adding a Vector-Display Capability

If you are determined to hunt "wild vectors," the same technique employed to provide a timing plot lends itself to vector display. Using the same methods to cycle the buffer data on the output lines of the analyzer, substitute D/A converters for the multiplexer in figure 5. Typically, two 4-bit D/A converters are needed. One would be attached to the 4 highorder bits and the other to the 4 loworder bits. One D/A converter is attached to the x-axis scope input and the other to the y-axis input. When the buffer is cycled, a unique vector pattern will appear on the screen, describing the 16 data words stored in the analyzer's buffer. (A more informative discussion on this approach to troubleshooting was one of my previous articles, "A Penny Pinching Address State Analyzer," February 1978 BYTE, page 6. It has been reprinted in Ciarcia's Circuit Cellar, Volume I, available from BYTE Books.)

Listing 1: A BASIC program that exercises the computer/logic analyzer interface, displaying output through the computer's normal output devices.

```
100 REM Logic Analyzer Program
110 REM
120 REM data in on port 16, scan complete on bit 0 of port 17
130 REM read enable and sample enable are bits 6 and 7
140 REM of port 16
150 REM read address is bits 0 thru 3 of port 16
160 REM memory locations 25000 to 25015 is set aside as the data
170 REM buffer
180 PRINT"LOGIC ANALYZER"
190 PRINT:PRINT"Enable New Sample or List Analyzer Buffer";
200 PRINT" (E or L)";
210 INPUT A$
220 IF A$ ="E" THEN 250
230 IF A$ ="L" THEN 380
240 GOTO 190
250 REM Enable Logic Analyzer and take 16 readings
260 REM pulse sample enable line and set read/write line=0
270 OUT 16,255:OUT 16,0: OUT 16,255
280 REM
290 REM test scan complete line
300 IF INP(17) =255 THEN GOTO 300
310 REM when scan is completed store readings in table
320 FOR S=25000 TO 25015
330 N=S-25000
340 REM set read address and store analyzer output
350 OUT 16,N :A=INP(16):POKE S,A
360 NEXT S
370 GOSUB 380
380 REM Ones and Zeros data-domain display routine
390 PRINT: PRINT
400 PRINT"D7 D6 D5 D4
                           D3 D2 D1 D0"
410 FOR S=25000 TO 25015 :X=PEEK(S)
420 FOR N=7 TO 0 STEP -1
430 W=X AND 2^N
440 IF W>O THEN PRINT"1
450 IF N=4 THEN PRINT"
                          "; ELSE PRINT"0
460 NEXT N
470 PRINT"
            SAMPLE #"; S-24999
480 NEXT S
490 GOTO 190
READY
```

Listing 2: Sample output produced by the program of listing 1.

RUN	
LOGIC	ANALYZER

Enable New Sample or List Analyzer Buffer (E or L)? E

D7	D6	D5	D4	D3	D2	Dl	D0			
0	0	0	0	1	1	1	0	SAMPLE	#	1
1	1	0	1	0	1	0	1	SAMPLE	#	2
0	0	1	1	1	0	1	0	SAMPLE	#	3
1	0	0	0	1	0	0	0	SAMPLE	#	4
0	0	0	0	0	0	0	1	SAMPLE	#	5
1	1	1	1	0	1	0	1	SAMPLE	#	6
1	1	0	0	1	1	0	1	SAMPLE	#	7
0	0	0	1	0	0	0	0	SAMPLE	#	8
0	0	0	1	0	1	1	0	SAMPLE	#	9
1	1	1	1	0	0	0	1	SAMPLE	#	10
1	1	1	0	0	0	1	1	SAMPLE	#	11
0	0	1	0	0	0	1	0	SAMPLE	#	12
1	0	1	0	0	1	1	0	SAMPLE	#	13
0	0	0	0	0	0	0	1	SAMPLE	#	14
0	0	0	1	1	1	1	1	SAMPLE	#	15
1	1	0	0	1	1	0	1	SAMPLE	#	16

Enable New Sample or List Analyzer Buffer (E or L)?

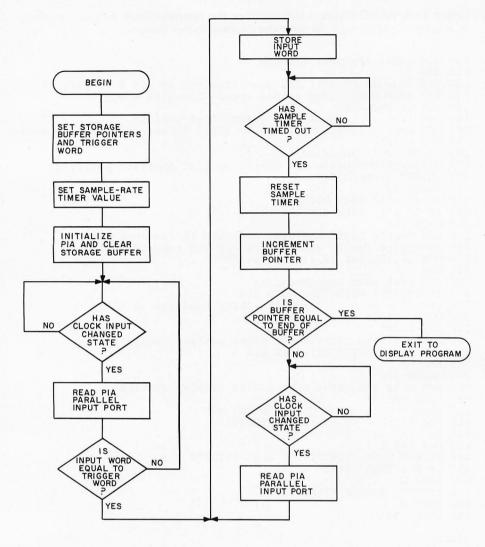


Figure 6a: Flowchart of a software logic analyzer. Using a Motorola 6820 PIA (Peripheral Interface Adapter), this sequence of operations is all that is required to demonstrate logic-analyzer functions in software. This method is limited in speed of operation by the execution time of the program.

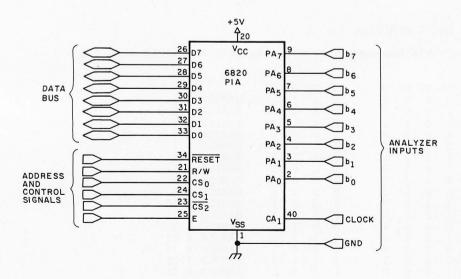


Figure 6b: Pinout chart of the Motorola 6820 PIA used by the algorithm of figure 6a.

Logic-Analyzer Functions Created Through Software

While I generally prefer to demonstrate hardware interfaces in my articles, the functions of a logic analyzer can easily be simulated in software if data-acquisition speed (under 20 kHz) is not critical. While it may not be appropriate for testing microcomputer bus signals, it should work for slower applications.

Figure 6 is a flow diagram outlining the specific steps involved in accomplishing this function. While any existing parallel input port will suffice, the Motorola 6820 PIA (Peripheral Interface Adapter) shown has a separate clock input, which greatly facilitates proper timing.

In Conclusion

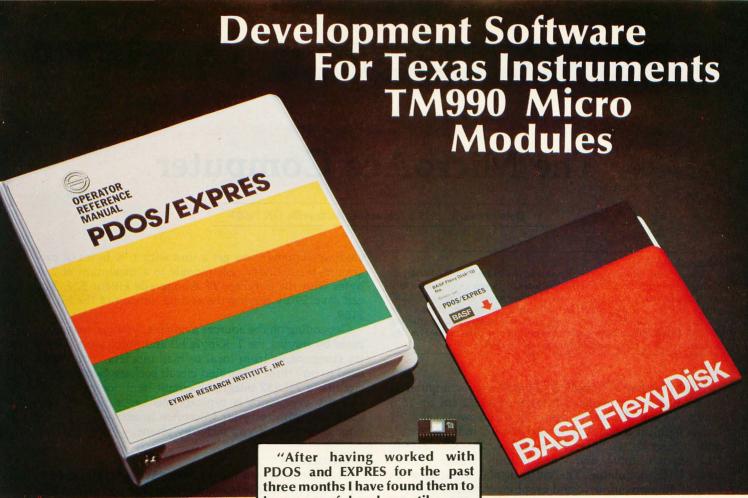
As digital hardware becomes more complex, the instruments used in troubleshooting and debugging these circuits must themselves become more sophisticated. This sophistication, however, need not always be provided in the form of a commercially produced test instrument. Often the solution can be intelligent application of existing equipment with limited modifications.

The logic analyzer I have described can be used for all types of trouble-shooting and testing of digital circuits. However, its true flexibility is revealed when the instrument captures the extremely fast data flowing in a microcomputer and generates a stationary timing diagram with the results. Built from scratch, combined with an oscilloscope, and exercised by a computer, this interface costs only a fraction of the price of commercial analyzers, yet approximates many of their features.

Next Month:

Build a remote-controlled motorized moving platform.
■

Editor's Note: Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458. Ciarcia's Circuit Cellar covers articles appeating in BYTE from September 1977 thru November 1978. Ciarcia's Circuit Cellar, Volume II presents articles from December 1978 thru June 1980.



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System Review

The MicroAce Computer

Delmar Searls, 1825 S Johnstone, Bartlesville OK 74003

About the Author

Delmar Searls is a professor of mathematics at Bartlesville Wesleyan College, Bartlesville, Oklahoma. His interest in microcomputers is a result of both professional and personal experience: he learned BASIC programming by using a PET microcomputer on the job; at home, he taught himself electronics, beginning with the basics, and continuing through digital electronics and microprocessors. His interest in the MicroAce was sparked by the remarkably low price.

The MicroAce is a small, Z80-based microcomputer in kit form. When completed it measures 23.2 cm by 18.8 cm by 4.1 cm (9% inches deep, 7% inches wide, and 1% inches high). It features an integer BASIC in ROM (readonly memory), touch-sensitive keyboard input, cassette I/O (input/output), and video output through an onboard UHF modulator. The video display consists of 24 lines of 32 alphanumeric and graphics characters.

The kit comes in two forms, depending on the amount of user-programmable memory purchased. For \$149 (in-

cluding shipping) you get a unit with 1 K bytes of programmable memory, expandable to a maximum of 2 K bytes with the purchase of an upgrade kit for \$29. You can save \$9 by buying the second version of the kit for \$169.

Depending on the sources available, you can save even more by buying the 1 K-byte kit and purchasing the extra components from local or mail retailers. You would need to buy three integrated-circuit sockets, two memory circuits, a 74LS32 integrated circuit, and one capacitor.

If my experience is typical, you can expect to wait about a month for your MicroAce to arrive if you mail your order; less if you order by phone.

Construction

The advertisement for the MicroAce (as it appeared in BYTE and in other magazines) states that you will receive a "teach-yourself BASIC manual" and that "a hardware manual is also included with every kit." This is not correct. There is no hardware manual supplied with the kit, only the BASIC manual which includes a section entitled "Construction," preceding the first chapter.

The assembly instructions are very general and, in my opinion, not quite sufficient for those who have no ex-

At a Glance_

Name MicroAce (kit)

Manufacturer MicroAce 1348 E Edinger Santa Ana CA 92705 (714) 547-2526

Price \$149 (with 1 K bytes of programmable memory)

Dimensions 23.2 cm by 18.8 cm by 4.1 cm (9½ inches by 7½ inches by 1½ inches)

Processor Z80, 8-bit

System Clock Frequency 3.25 MHz

Memory 4096 bytes of ROM

1024 bytes of programmable memory

Mass Storage

Cassette tape recorder supplied by user

Other Features

Touch-sensitive keyboard, RFmodulated output (UHF channel 35), display of 24 lines by 32 characters

Documentation

Teach-yourself BASIC manual (67 pages)

Audience

Anyone who wants an inexpensive microcomputer



Photo 1: The MicroAce kit as shipped. Starting at the bottom and moving clockwise around the main circuit board are: the discrete components, the integrated circuit sockets, the integrated circuits themselves, voltage regulator, power supply, UHF modulator, antenna switch box, cable materials, and black plastic case. The 8- by 11½-inch instruction manual gives an indication of the size of this computer.

perience in circuit-board kit construction. There are no guidelines for proper soldering techniques and no step-by-step instructions that are commonly found with kits from the larger kit manufacturers.

Component values are written in a rather unusual notation. For example, a resistance of 470 ohms is written 470R, 1000 ohms is written 1K0, 2200 ohms is written 2K2, 47,000 ohms is written 47K, and 1,000,000 ohms is written 1M0.

There is a logical pattern to the notation, but it is different from that which is normally used. I suspect that the notation is British, since the MicroAce is essentially the kit version of the Sinclair ZX80, which is made in England.

Another unusual practice is the frequent listing of capacitance in nanofarads rather than picofarads. While this notation may be unusual, it should not cause any real problem as color codes and identifying marks are also listed for the various components.

The smaller components are packaged in plastic bags, while the larger items are packed loose (see photo 1). There were no missing parts, and, in fact, I received three extra resistors and one extra capacitor. There was a moment of concern when I discovered that the parts list called for eleven diodes and only nine had been supplied. A close inspection of the circuit board, however, revealed that only nine were required.

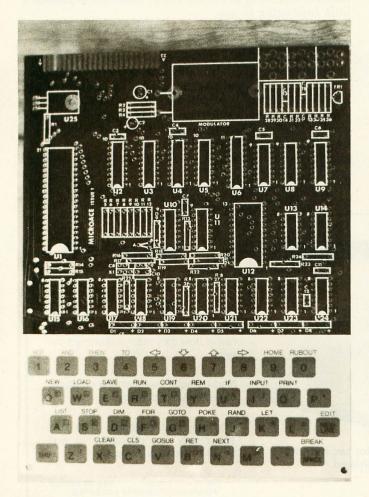


Photo 2: Component side of the main circuit board. Note that component locations are clearly marked, and that the keyboard is an integral part of the printed-circuit board.

The circuit board is double sided with holes soldered through. Component locations are indicated by white outlines and white identification labels on the component side of the board (see photo 2). Component type and value is determined by cross-referencing the identification label (R2, C12, U8, etc) with the parts list.

The actual assembly is straightforward and very easy, especially for those familiar with circuit-board projects. The construction notes suggest that components be soldered to the board in the following order: sockets for the integrated circuits, discrete components, cable sockets, voltage regulator, and the video modulator.

Next, the integrated circuits can be installed. Be sure to follow the appropriate precautions when handling the MOS (metal-oxide semiconductor) devices, which include the Z80, two programmable-memory chips, and the ROM circuit. At this point the unit can be tested for proper operation. The last stage in construction, following successful testing, is the installation of the unit in its case (see photo 3).

The 1 K-byte version of the kit does not provide the sockets for three circuit locations. (These are supplied with the upgrade kit.) I suggest that anyone building this version use masking tape to identify these locations prior to construction. Otherwise, it would be easy to install a socket in one of these locations, only to come up short later on. Once a socket is soldered in, it is practically impossible to remove.

There are no instructions given for the preparation of the cables that will attach your television and cassette recorder. You are provided with about 10½ feet of shielded cable, two phono plugs, and four mini-jacks. As simple as this task may appear, more instructions should



Photo 3: Completed MicroAce with cables.



Photo 4: Sample program displayed on a standard color television set. The current program line is 180, as indicated by the reverse-video cursor.

have been given to aid the inexperienced builder.

The fastenings provided for attaching the circuit board to the lower half of the case, and for fastening the upper half of the case to the lower, are plastic devices referred to as "rivets." In my opinion, these fasteners are inadequate. In fact, the rivet at one circuit-board location was useless and kept popping out. To remedy the problem, I used a fine round file to enlarge the holes in the plastic case, and substituted small nuts and screws for the rivets. Plastic washers were used to prevent the circuit board from becoming marred.

The keyboard appears to be built up with two layers. The bottom layer consists of the front one-third of the circuit board, while the second layer is laid on top and seems to be secured with some sort of adhesive. This is done by the manufacturer, not the kit-builder.



Photo 5: Layout of the MicroAce keyboard. Note that each BASIC keyword is associated with a specific key.

On my unit, this overlay was positioned slightly too far to the left, so that I had to press the right edge of the key, rather than the middle, to get a response to the keyboard entry. In addition, some keys require considerably more pressure than others. These factors, plus the fact that no audio or tactile feedback is given to indicate a successful keyboard entry, make the keyboard a little frustrating to use.

Program Entry

The output of the modulator is received on or near channel 35 on a regular television set. I used an RCA 13-inch color set and had no trouble obtaining a good display. With the controls set for normal reception of commercial broadcasts, the display appears as white characters on a gray background. If desired, white letters on an almost black background can be obtained by adjusting the contrast and brightness controls (see photo 4).

On power-up, the display is blank with the exception of a reverse-video "K" at the lower-left corner of the screen. Whenever this reverse K appears, a nonshifted

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keyboard entry from the bottom three rows of keys (see photo 5) will result in a BASIC keyword being printed on the screen.

Keywords (and thus the use of a reverse K) are BASIC commands which are stored in a single byte of memory but are spelled out on the screen. For a list of these keywords, as well as other BASIC commands and functions, see table 1.

Nonshifted keyboard entries from the top row are printed as numeric characters for the line numbers (which must be between 1 and 9999, inclusive). As a line number is entered, the reverse K will shift to the right, one space at a time. As long as the reverse K is on the screen, any shifted-key input (other than an editing command) will result in a syntax error. Commands entered without a preceding line number are executed immediately in the command mode."

After entering a line number, press the key corresponding to the BASIC keyword with which your program line is to begin. Every program line must start with one of these keywords. For example, in some forms of BASIC, the LET keyword is optional, and "10 LET A=5" can be written "10 A=5". This is not possible with the MicroAce.

Following the entry of a keyword, the reverse K cursor changes to a reverse L, signifying that you are in the letter mode and that keyboard entries will be interpreted as regular alphanumeric or graphics characters. As you type in a program line, the system monitor checks for syntax errors after each character is entered. A line contains a syntax error if, in its present form, the line is incorrect or incomplete. Suppose you wish to enter the following line:



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20 PRINT "THE FINAL SUM IS"; A

The PRINT command is entered by pressing one key (the letter O) because the machine is in its keyword mode at the start of each new line. Immediately following the entry of the first set of quotation marks, a reverse-video S (for syntax) appears to the right of the reverse-L program cursor. This does not indicate that an error has been made, but rather that the line is incomplete. As the literal

Keyword Commands					
Keyboard Abbreviation	Comments				
CLEAR	Set all variables to zero				
CLS CONT	Clear the screen Continue				
DIM FOR	Dimension (one-dimensional arrays)				
GOSUB					
GOTO IF					
INPUT LET					
LIST LOAD	Cassette input				
NEW	Cassette input				
NEXT POKE					
PRINT RAND	Randomize				
REM RET	Remark Return				
RUN					
SAVE STOP	Cassette output				
	String Functions				
Function	Comments				
CHR\$(N)	Return character or keyword string corresponding to decimal code N.				
CODE(S)	Return decimal code number of first				
STR\$(/)	character in string S Convert the integer / into its corresponding				
TL\$(S)	string representation. Delete the first character from string S.				
	Other Functions				
Function	Comments				
ABS(N) PEEK(N)	Return absolute value of N. Return decimal value stored in memory at				
	address N.				
USR(N)	Start machine-language routine at address N.				
RND(N)	Return a random number between 1 and N if N is positive.				
	Logical Functions				
Function	Comments				
AND	Check to see if two or more conditions are met simultaneously.				
OR	Check to see whether any one of two or more conditions is met.				
NOT	The opposite of a stated condition is tested.				
(These logical functions have additional uses which cannot be detailed here.)					
	Arithmetic Operations				

- Addition Subtraction
- Multiplication
- Division
- Exponentiation (2**3 = 2*2*2 = 8)

Table 1: Commands and functions available in MicroAce integer BASIC, with comments at selected points. The manual supplied with the kit provides a more detailed explanation.

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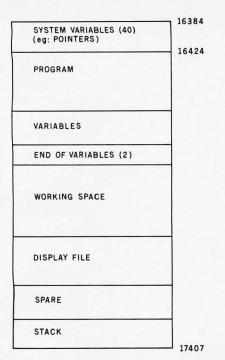


Figure 1: Map of the programmable memory in the MicroAce computer. Fixed boundary addresses are given in decimal; the other boundaries are variable. Numbers in parentheses give the size of a fixed block in decimal bytes.

string is entered, the reverse LS moves to the right as a double cursor. When the second set of quotation marks is entered, the reverse S disappears because the line now has the correct syntax.

Consider a second example. You wish to enter the line:

125 LET I=I+1

but inadvertently type:

125 LET I+1=I

This line would not be accepted because it contains a syntax error. The reverse S cursor would be located directly after the + symbol.

Notice that in this case the reverse S does not follow the reverse L cursor, but remains at the point where the error occurred. In the case of multiple errors, the reverse S will always be located at the first error contained in the line. When this error is corrected, the reverse S moves to the second error, and so on.

As indicated above, no line containing a syntax error will be accepted into a program. This guarantees that every line in your final program is complete and free of syntax errors. It does not, of course, prevent errors of logic. When a line is complete and correct, it can be entered into a program by pressing the NEWLINE key—the MicroAce equivalent of a RETURN key.

As a line is entered into a program it is placed into memory in two places. First, it is placed into the program storage area, which begins at decimal address 16424. (See figure 1 for a simplified map of the programmable memory.) It is also relocated in the display-file section of memory so that it appears on the upper portion of the screen.

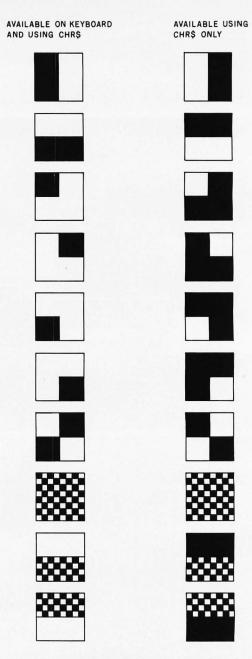


Figure 2: Graphics symbols available with the MicroAce. Note that the first ten symbols are addressable from the keyboard, while the second ten are their reverse-video images, available only through the use of the CHR\$ function in BASIC.

Recall that on power-up the reverse K was at the lower left and that line entry was done at the bottom of the screen. As new lines are entered they appear in numerical order. The most recently entered line is identified by a line cursor (a reverse video >).

A line entered with a number between those of two previously entered lines is placed in the appropriate position on the display, and the line cursor is moved to its location. When the screen is full, the addition of new lines causes the program listing to scroll up, always leaving the most recently entered portion on the display.

This method of using programmable memory for both program storage and display storage leads to problems. In some systems, the video-display memory is dedicated, meaning that an advertised 1 K bytes of programmable

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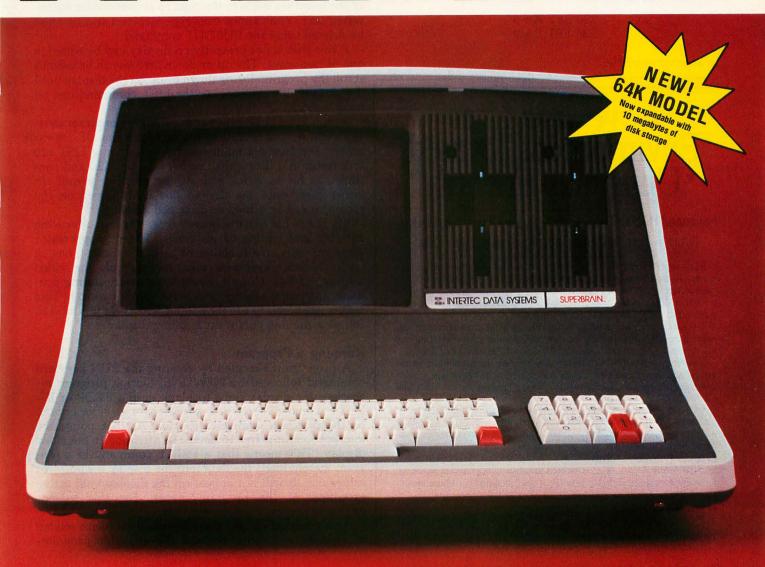
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memory are used for program storage only, and that additional memory is supplied for storing video data.

With the MicroAce, the programmable memory available to the user must perform both tasks. Thus, as program length increases, the area for displaying the program listing begins to shrink as less and less memory is available for display storage. As a result, the program line-entry "window" moves up from its bottom position on the screen. The advantage of this system is that when your line-entry window is near the top of the screen, you know you are close to filling the available program memory. The disadvantage is that shorter and shorter segments of a program can be listed at any one time. As you will see later, this dual use of memory causes similar difficulties when running a program.

Another feature of the MicroAce is that there is no limit (other than available memory) to the length of a program line. Thus, a large section of text can be printed using a single PRINT command. This can save time and

memory if properly used.

A disadvantage of the system is that multiple statements on a single line are not allowed. For example:

230 LET A=5: LET B=9

would have to be written as:

230 LET A=5 235 LET B=9

In another example:

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200 INPUT A 205 INPUT B 210 INPUT C

Program Editing

As indicated earlier, new lines can be inserted anywhere in a program by entering them in the normal fashion. Entire lines can be deleted by entering the line number and pressing NEWLINE. If the line that is currently displayed needs editing, the following procedure is used: the up and down arrows (shifted 7 and shifted 6, respectively) are used to locate the line cursor at the proper line; then EDIT (shifted NEWLINE) is pressed to copy the desired line in the program-entry window at the bottom of the screen.

The left and right arrows (shifted 5 and shifted 8, respectively) are used to position the program cursor within the line. Deletions are made by placing the program cursor to the right of the desired character or keyword and pressing RUBOUT (shifted numeral 0).

Insertions are made by merely typing in the correct character or keyword. The portion of the line to the right of the insertion shifts to the right to accommodate the inserted text. You cannot over-type incorrect text; it must be deleted using the RUBOUT command.

A line that is not presently on display can be edited in one of two ways. The up or down arrows can be used to scroll the program listing down or up on the display until the desired line appears, or the LIST command can be used instead.

Normally, a LIST command will list the program starting with the line preceding the requested line. If, for example, the lines are numbered by tens, then a LIST 120 will result in a listing that begins with line 110 and continues as far as space and display memory permit. In either case, once the desired line is displayed on the screen, it can be edited as described above.

MicroAce has one disconcerting feature that affects the entering and editing of programs. The microprocessor performs only one function or task at a time. Thus, it either handles keyboard input or controls the video display, and as a result, every key closure during program entry and editing causes the display to roll. This makes it difficult to use the editing arrows, as it is hard to follow a moving cursor on a rolling display.

Running a Program

A program is executed by entering the RUN keyword command followed by NEWLINE. During program execution, the display remains blank until a STOP or IN-PUT command is executed, a BREAK or an error occurs, or the program completes its run. At that point, the microprocessor is free to devote its attention to the video display. This means that a PRINT command in a program merely loads the data into the display memory for future use. It will not appear on the display until active execution of the program ceases. For this reason, animated graphics are not possible.

As mentioned earlier, there are some problems related to running programs, because the available program-

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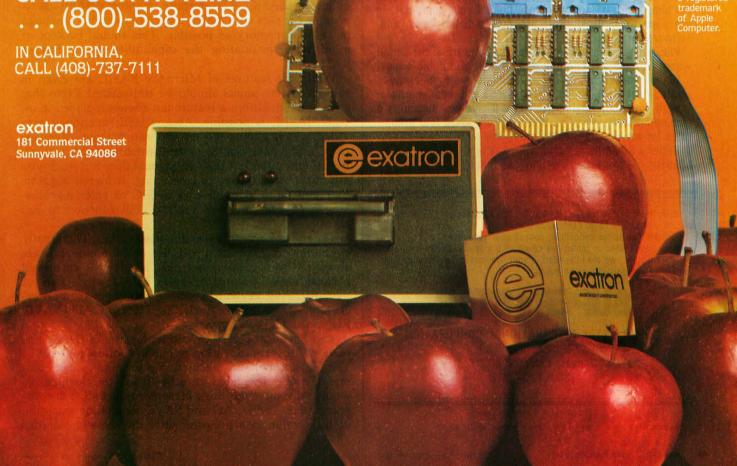
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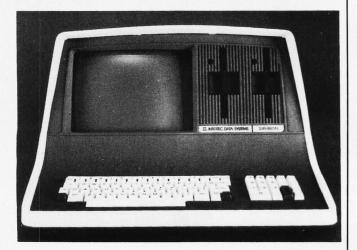
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mable memory is used for both program and display storage. Program memory is given priority, so if, for example, a PRINT command giving some instructions contains more characters than the available display memory can accommodate, the displayed message terminates at the point where display memory was filled, program execution stops, and an error message appears at the lower-left portion of the screen.

This clearly limits the amount of displayable text that can be included in a program. In the worst possible situation, where the entire screen is filled, 768 bytes of memory ($32 \times 24 = 768$) would be required for the display alone. Only 256 bytes remain in which to store system pointers, program lines, variables, and so on.

Furthermore, the display will not scroll during program execution. If a PRINT command results in a line of text beyond line 24, program execution ceases and a different error message is displayed. The PRINT and CLS (clear screen) commands must be used judiciously in order to avoid printing too many lines, on the one hand, and clearing text before it can be read, on the other.

MicroAce Integer BASIC

Integer BASIC is limited in its computational capabilities. All numbers used in computation must be integers in the range -32768 to 32767, inclusive. Results of arithmetic operations are truncated (ie: all fractions are dropped). Thus, 99 divided by 100 would come out 0, because the division normally yields a quotient of 0.99. But integer BASIC drops all fractions, leaving 0.

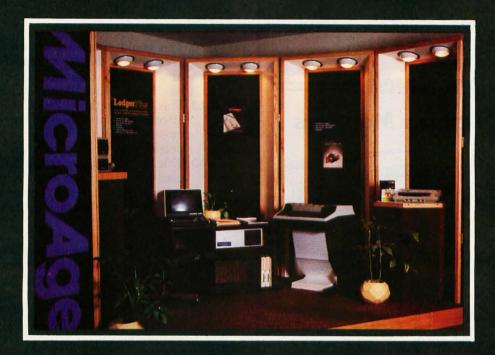
Only the fundamental operations of addition, subtraction, multiplication, division, and exponentiation (using positive integral exponents) are implemented. This is true not only for MicroAce integer BASIC, but for any form of integer BASIC. The purpose of integer BASIC is to provide the user with a high-level programming language in as little memory as possible. This should be kept in mind when evaluating the capabilities of an integer BASIC.

While the features of MicroAce BASIC are given in table 1, a few points should be emphasized. Note that string manipulation, a feature not always included in integer BASIC, is possible. Also, a USR function is provided which allows the user to run machine-language programs. I have not yet experimented with this feature, but should point out that the manual does not teach you any machine-language programming. It merely suggests that you write a monitor in BASIC to enter machine-language programs, and use the USR function to run them.

The use of keywords was discussed earlier. This greatly simplifies program entry because entire commands are entered with a single keystroke. Memory is conserved because each keyword occupies only a single byte of memory. Any keyword command can appear in an executable program line including LIST, LOAD, SAVE, RUN, and NEW.

You have to be very careful with some of these commands. Program execution terminates following a LIST. The NEW command executed in a program, or in command mode (executed directly from the keyboard), would wipe out everything in memory, including the program itself. The LOAD and SAVE commands would be of little value in a program since the cassette recorder

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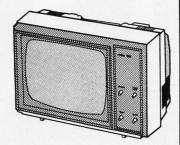
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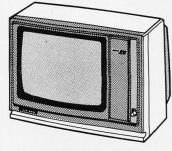
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would have to be turned on at just the right moment in order to complete the command execution.

The MicroAce BASIC provides an error message whenever program execution ceases. The number of different messages is limited, but remember that all program lines must have correct syntax before they are accepted into a program. The error messages are given in the format c:nnn where c is an error code, and, in most cases, nnn is the last program line executed. Here are some examples:

0:400 This could mean one of two things. Either the program has come to a successful end at line 400, or a BREAK was executed and line 400 would have been the next line executed in the program.

5:40 This indicates that a PRINT command in line 40 attempted to print beyond the twenty-fourth line on the display, which, as noted above, is not possible.

possible.

4:40 This might indicate that a LET command was used when there was no more memory available for variables storage. (The error code indicates there is not enough memory to perform the given line.)

The system of error messages, together with the syntax checking feature, make program debugging quite easy. This is definitely one of the strong points of MicroAce BASIC.

One negative aspect of the MicroAce BASIC is the inability to halt program execution at an INPUT command. When executing an INPUT command, the BREAK key is, in effect, ignored. This is not that unusual as other computers exhibit the same property. However, any key entry, including NEWLINE (and that is a bit unusual), that is not a valid response to the INPUT command results in the appearance of the reverse-video S syntax error cursor, which means that the response will not be accepted. It must be deleted using the RUBOUT command, and a correct response must be entered before program execution resumes.

I entered a relatively simple game program which involved locating a submarine within a three-dimensional region. The player is allowed seven trials, and must input three coordinates during each trial. Thus, a maximum of twenty-one INPUT commands will be executed. Unless a STOP command or an escape routine is included in the program (or you disconnect the power), there is no obvious way to terminate execution of the program until all twenty-one INPUTs are responded to properly. This could make debugging of highly interactive programs a time-consuming process. By the way, even though this program was quite short, the instructions for playing the game could not be displayed without overflowing the available display memory. Consequently, they had to be omitted from the program.

Graphics

There are twenty graphics symbols available, as shown in figure 2. Note that only ten are available from the keyboard. The remaining ten are reverse-video graphics available by using the CHR\$ function.

In fact, any alphanumeric character, graphics symbol, or keyword string can be printed using the CHR\$ func-

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tion. Most characters can be printed in reverse-video as well. The BASIC manual provides a complete list of all available characters and strings, along with their decimal codes. The code is unique to MicroAce and thus not compatible with standard computer codes.

Since each character position on the 24 by 32 display is divided into four parts by the graphics symbols, a resolution of 48 by 64 dots is possible. Remember though, that an extensive graphics display greatly limits the amount of memory available for program storage.

Cassette Input and Output

I had to try two tape recorders before I could successfully load a program from tape. The first recorder I tried lacked a tone control and could not load a program, regardless of the volume setting. The second recorder had a tone control and loaded properly with the control set at maximum treble.

The proper volume level seems to vary from tape to tape, even when they are made by the same company. Before saving a program, the program name is recorded

on the tape by voice.

A cable is attached between the microphone output of the computer and the microphone input of the recorder. The recorder is placed in its record mode and the SAVE command is entered followed by NEWLINE. The television screen goes blank for about five seconds, followed by a jumpy display of horizontal white lines. This indicates that the data is being output to the recorder. When the display returns to normal, the save is complete.

Loading a program involves a similar series of steps. In

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this case, however, you cannot be certain that the program is being input until the screen resumes its normal display, giving a listing of the tail end of the successfully loaded program.

If, after a reasonable interval of time, the display does not return to normal, the BREAK key may be used to reset the computer. Occasionally, you may have to disconnect the power momentarily to recover from an unsuccessful load. Once the proper volume setting is found, however, loading can be done quite reliably.

The Teach-Yourself Manual

The manual supplied with the MicroAce, entitled The Teach-Yourself BASIC Manual, is shown in photo 1. The title may be slightly misleading. It brings to mind a tutorial text complete with exercises for the reader, but it is not that kind of text. It merely introduces the BASIC commands, one at a time, illustrating their proper use and perhaps some typical applications.

At the same time, the processes of program entry, program editing, and program execution are taught. Token coverage is given to the art of programming, but in all fairness it might be unreasonable to expect a more detailed explanation. As an introduction to the use and syntax of fundamental BASIC commands, the manual is

quite adequate.

While typing errors (or misprints) are inevitable, I do think that special care should be given to printing sample programs. One program in the manual has two lines which read "GO TO 7000" when the program contains no line numbered 7000. Those two lines should have read "GO TO 1000". As written, the sample program would not run successfully.

Other Considerations

I believe that any product's value is partially determined by the manufacturer's willingness to respond to the consumer's request for aid or assistance. Nine weeks prior to the writing of this review, I sent a letter to MicroAce requesting answers to specific questions related to the MicroAce and to future plans for upgrading and expansion. That letter was never answered. This, to me, indicates a lack of interest in serving the customer.

At the same time that the letter was sent to MicroAce, a similar letter was sent to Sinclair Research Limited, the company that markets the Sinclair ZX80. (The MicroAce is essentially a kit version of Sinclair's machine and is manufactured under a license from Sinclair Research Limited.)

Sinclair's response to my letter left many questions unanswered (especially in regard to future plans), but they did say that the MicroAce operates in the same manner as the ZX80. Consequently, the comments made in this review concerning the operation of the MicroAce would apply to the Sinclair ZX80 as well.

I was also told by Sinclair that while the unit operates like the ZX80, it is not identical to it, and that peripherals marketed for the ZX80 might not work with the Micro-Ace. They did not elaborate, and, as noted above, Micro-Ace had no comment at all.

Conclusions

The MicroAce kit is a very inexpensive introduction to the world of microcomputers. Kit construction is easy

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enough that beginners can tackle the project with confidence, assuming that they learn correct soldering techniques.

Proper soldering is so crucial to success that I would advise those with no experience to purchase Heathkit's soldering course. This course is part of Heathkit's continuing education program, and costs \$15.95 plus shipping. While I have not seen this particular course, I am sure, based on my experience with their other products, that it would be worthwhile. For further information, write to Heath Company, Benton Harbor MI 49022.

MicroAce BASIC contains several nice features. The use of keyword commands simplifies program entry and reduces the amount of memory required for program storage. Because line syntax is checked before the line is entered into a program, fewer programming errors can occur. This feature is especially useful for those just learning how to use BASIC.

The machine's compact size and light weight make storage and transportation very easy. The unit is simple to attach to a home television set, and the cassette input and output operations are reliable, once the proper settings are found.

The largest drawback is the severely limited amount of programmable memory. This disadvantage is most apparent when you try to write any but the shortest programs utilizing a significant amount of video display. I would strongly encourage any prospective buyer to purchase the 2 K-byte version of the MicroAce. Another drawback is that the screen is blank during active program execution. This limits the types of possible graphic displays, and can be somewhat annoying.

If you recognize the limitations of the machine and don't expect too much, then I think you can buy the MicroAce kit with confidence. It is most appropriate for someone who wants an inexpensive unit as a teaching tool in order to learn the fundamentals of BASIC programming. It might also appeal to hobbyists who want to "tinker around" with microcomputers but don't want to risk their more expensive equipment.



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Digital Minicassette Controller

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The microcomputer-system designer has had a difficult time finding low-cost storage devices. Frequently, the choices have been limited to either standard Phillips audio cassettes or floppy disks. Although these are relatively inexpensive storage media, the transport mechanisms, or drives, are not. In addition to the transport, a controller and data formatter is required to interface the transport to the microcomputer system. The controller may either be a dedicated LSI (large-scale integration) device or be

Commonly used massstorage mechanisms and associated controllers are often quite expensive.

built up discretely from SSI (small-scale integration) logic consisting of TTL (transistor-transistor logic) gates and flip-flops.

for a floppy-disk drive). As a bonus, the transport is extremely compact (only 23 cubic inches) and requires little power (1 watt). This makes it suitable for a wide range of low-end applications ranging from experimental systems to data logging for test instrumentation. There is one problem with designs using a minicassette: controlling it. There are several choices for the transport controller. One choice is to design a controller of discrete SSI logic. Although this choice will provide good performance, it requires a handful of discrete components. The SSI controller will use much circuit-

board space, compromising the advantage of a compact transport. A better design would use a minimal number of components and take ad-

There is now another choice

besides the floppy disk and the

Phillips cassette: the digital mini-

cassette. Not only is the storage

medium inexpensive, so is the

transport (about \$140, versus \$400

vantage of current LSI technology. One such controller-design solution is to use the Intel 8255A Programmable Peripheral Interface IC (integrated circuit) to interface the transport to a microcomputer system. Although this design provides a simple solution to the problem, the processor would be burdened with providing the low-level control needed by the transport, in addition to supporting its normal real-time I/O (input/output) tasks. Examples of these low-level tasks are transport start-up. data formatting, and transport shutdown.

There is, however, a better LSI solution available: distribute the system intelligence from the micro-

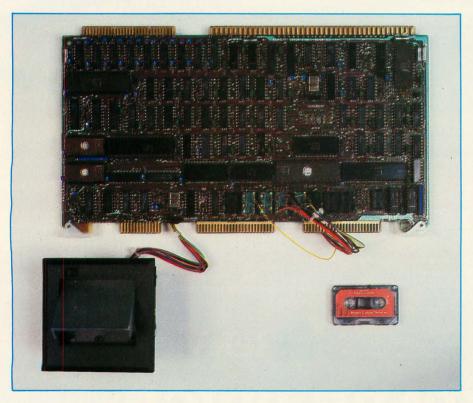


Photo 1: The author's minicassette system includes an Intel iSBC 80/30 single-board computer and a Braemar CM-600 Mini-Dek transport.



The best news since CP/M... customizable full screen editing

As a serious computer user you spend much of your time editing, whether it be for program development or word processing. Make the best use of your time with the help of VEDIT, an exceptionally fast and easy to use full screen editor. VEDIT is a highly refined and proven editor which is easy enough for novices to learn and use. Yet its unequalled set of features also makes it the choice of computer professionals. And because VEDIT is user customizable, it adapts to your keyboard, hardware, applications and preferences.

In VEDIT, the screen continuously displays the region of the file being edited, a status line and cursor. Changes are made by first moving the cursor to the text you wish to change. You can then overtype, insert any amount of new text or hit a function key. These changes are immediately reflected on the screen and become the changes to the file.

VEDIT has the features you need, including searching, file handling, text move and macros, plus it has many special features. Like an 'UNDO' key which undoes the changes you mistakenly made to a screen line. And a mode which allows a programmer to enter all text in lower case and let VEDIT convert the labels, opcodes and operands, but not the comments, to upper case. The screen writing is almost instantaneous on a memory mapped display or can use your CRT terminal's editing capabilities. Disk access is very fast too, and VEDIT uses less than 12K of memory. The extensive 70 page, clearly written manual has sections for both the beginning and experienced user.

Totally User Customizable

Included is a setup program which allows you to easily customize many parameters in VEDIT, including

the keyboard layout for all cursor and function keys, screen size (up to 70 lines, 200 columns), default tab positions, scrolling methods and much more. This setup program requires no programming knowledge or 'patches', but simply prompts you to press a key or enter a parameter.

The CRT version supports all terminals by allowing you to select during setup which terminal VEDIT will run on. Features such as line insert and delete, reverse scroll and reverse video are used on 'smart' terminals. Special function keys on terminals such as the H19, Televideo 920C and IBM 3101, and keyboards producing 8 bit codes or escape sequences are also supported.

New Features and Support

The new release includes disk write error recovery, indent and undent keys for structured programming, and the ability to insert a specified line range of another file at the cursor position. Versions for MP/M^R and the Apple II^R SoftCard^R are now also available.

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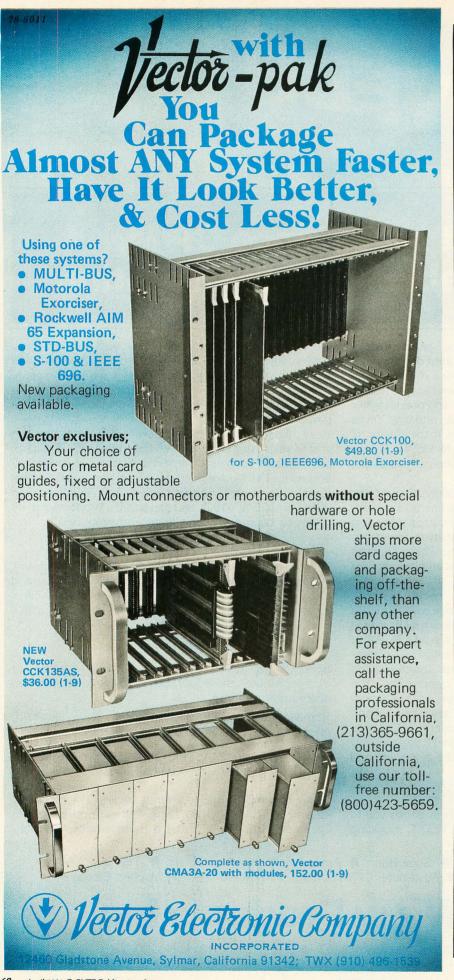
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processor to its peripheral devices by using an intelligent peripheral controller to carry the burden of low-level peripheral interface requirements. The processor now interfaces at a higher level, issuing the appropriate command to the controller and transferring the data to and from the controller in response to its I/O requests.

The controller provides a buffer between the processor and the transport. For example, the cassette transport expects data in a serial format, while the microprocessor is designed for handling data in either 8-bit words or 16-bit words. The controller performs data conversion from serial to parallel and buffers the data. This buffering is necessary to compensate for the I/O-service latency caused by other time-critical tasks handled by the microprocessor (ie: the data is held until the computer can devote itself to the controller). As a direct result, the system's work load is reduced, allowing it to utilize this savings in time to support other tasks, yielding a higher-performance microprocessor system.

Applying this to the minicassette design, we look through the available literature for dedicated single-device cassette controllers. Unfortunately, there are no devices of this caliber for minicassettes. There is, however, another solution: use the Intel UPI-41 Universal Peripheral Interface (UPI) integrated circuit. Two versions are available; we can use one of them, the 8741A, and design software, customizing it to control the minicassette transport.

The 8741A, shown in figure 1, is a complete, single-chip microcomputer containing 1024 bytes of EPROM (erasable programmable read-only memory), 64 bytes of programmable memory, 18 programmable I/O lines (providing a direct interface to the peripheral device), and a timer/event counter with an 8-bit prescaler for real-time I/O. In addition, it contains a complete slave-microprocessor bus interface, including both interrupt and direct-memory-access capabilities. A pin- and function-compatible factory-mask ROM (ie: programmed only at the factory) version of the UPI-41, the 8041A, is also available.

The 8243 I/O-port expander completes the system and interfaces directly to the I/O port of either of

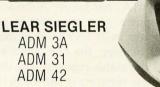
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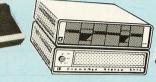
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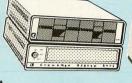


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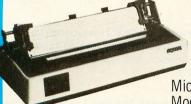




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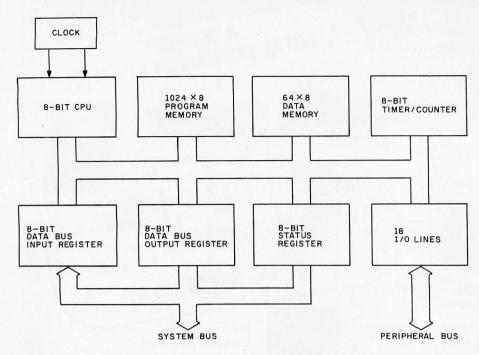


Figure 1: Internal block diagram of the 8741A/8041A Universal Peripheral Interface. I/O lines can be programmed as inputs or outputs; 8041A control-program memory must be factory programmed; 8741A memory is user-programmed.

the two slave microcomputers. Each 8243 provides 16 programmable, bidirectional I/O lines.

Using the 8741A allows the designer to develop a custom peripheral interface for particular I/O problems. These devices have found applications in such diverse areas as character-printer control, data encryption, keyboard control, and intelligent displays. Developing an 8741A design is straightforward. The

designer develops a control algorithm using the UPI-41A cross assembler and programs the on-board EPROM of the 8741A. Testing may be accomplished using either an ICE-41A in-circuit emulator or the single-step mode of the 8741A.

The Hardware

The complete microcomputer system is shown in photo 1, including the CM-600 minicassette transport.

The microcomputer system for this design consists of an Intel iSBC 80/30 single-board computer. It supports an 8085A microprocessor, 8 K bytes of EPROM, and 16 K bytes of programmable memory. In addition to an 8255A parallel interface and an 8251A serial interface, it contains a Multibus system bus connector allowing expansion beyond the board's local resources. Incidentally, there is an 8741A socket built into the board as well.

Let us examine the microcomputerto-8741A hardware interface. The computer sees the 8741A as three registers in its I/O address space: the data register, the command register, and the status register. The decoding of these registers is shown in figure 2. Within the 8741A, both the data and commands are written into the same physical register, the Data Bus Buffer Input register (DBBIN). The state of the register-select input, Ao, determines whether a command or data has been written ($A_0 = 0$ for data). All output to the microprocessor is read from the Data Bus Buffer Output register (DBBOUT).

The status register is composed of 4 software-programmable bits and 4 reserved bits reflecting the state of the 8741A slave microcomputer (see figure 3 on page 78). The Input Buffer Full (IBF) bit and Output Buffer Full (OBF) bit reflect the state of the DBBIN and DBBOUT registers, respectively. Flag 0 (F₀) and Flag 1 (F₁) can be set and complemented via the

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The Micromodem II consists of two parts. One part includes the printed circuit board which holds the Micromodem II, ROM firmware and the serial interface. The board plugs directly into the Apple II providing all the functions of a serial interface card plus programmable auto dialing and auto answer capabilities. The on-board ROM firmware enables the Micromodem II to operate in any of three modes to perform different tasks-terminal mode, remote console and program control mode.

The other part of the Micromodem II datacomm system is a Microcoupler which connects the Micromodem board and Apple II to a telephone line. The Microcoupler gets a dial tone, dials numbers. answers the phone and hangs up when a transmission is over. There are none of the losses or distortions associated with acoustic couplers. The Microcoupler is compatible with any North American standard telephone lines and is FCC-approved for direct connection in the U.S. It works with standard dial phone service or Touch-tone service.

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The Micromodem II can also be used with the Bell & Howell computer.



internal software. The remaining 4 bits are used to indicate the status of

the transport.

The TTL-compatible I/O lines of the 8741A provide an uncomplicated interface to the CM-600 Mini-Dek minicassette transport (Mini-Dek is a registered trademark of Braemar Computer Devices Inc). The I/O lines can be divided into three groups: motor control, data control, and cassette status. These I/O port lines are shown in the 8741A interface schematic in figure 4 on page 78. The motor-group controls are go/stop, fast/slow, and forward/reverse. The data controls are read/write, data-in, and data-out. The remaining group of outputs reflects the CM-600's status: clear leader, cassette present, file protected, and cassette side.

The Braemar CM-600 Mini-Dek transport is representative of digital minicassette transports. The transport is compact, requiring only 3 by 3 by 2½ inches for mounting. It has a single read/write head and uses only one drive motor. Operating from a 5 V supply, it has modest power-supply requirements, needing only 200 mA during a read or write.

Tape speeds are 3 ips (inches per second) during read/write, 5 ips for fast forward, and 15 ips during rewind. Calculating the data-transfer rate based on the read/write speed and the maximum recording density of 800 bpi (bits per inch) yields a maximum data-transfer rate of 2400 bps (bits per second). A more useful representation illustrating the significance of this number is obtained by inverting it. This yields the bit-cell period: 416 μs. This control requirement is easily met by the 8741A, its timer having a minimum resolution of 80 us. If finer resolution were required, softwaretiming loops would have to be used. The maximum resolution is limited to the instruction-cycle time of the 8741A, 2.5 µs, necessary for transfer rates of 8000 bps.

Recording Format

Since the CM-600 does not provide any data formatting, the 8741A must perform this additional low-level task. A multitude of encoding techniques are available from which the user may choose [ie: NRZ1 (Nonreturn to Zero, change if 1), Phase, GCR (Group Code Recording)]. For

this application, a "self-clocking" phase-encoding scheme similar to that used in floppy disks was selected. Phase encoding provides easy encoding and decoding of the serial data, embedding the timing information and data bits together in the recorded bit cells on the tape. This is an effective means of compensating for speed variations of the drive. Reading the data is accomplished by using the clocking information of the bit cell to synchronize the sampling of the data bit coming from the transport.

Figure 5 on page 78 illustrates this encoding technique as applied to the hexadecimal character 3A (all characters referenced in this article are hexadecimal). Notice that each bit cell begins with a transition to a logic level opposite the level of the preceding bit-cell level. Decoding the data is simply a matter of starting a timer on this "clocking" transition of the cell, waiting 3/4 of a bit-cell period, and determining whether a mid-cell transition occurred. Cells with no mid-cell transitions are 0s; cells with transitions are 1s. Besides the encoding

Text continued on page 80



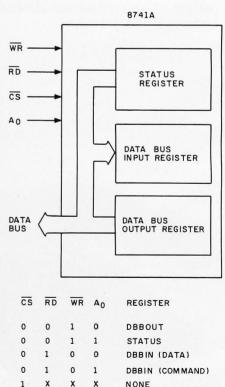


Figure 2: 8741A system-bus interface and register decoding as seen by the host processor

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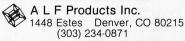
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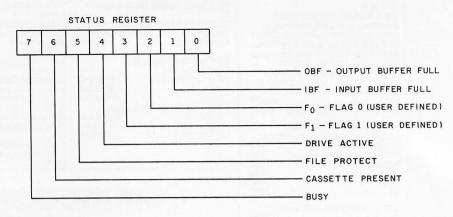


Figure 3: Definitions of the status-register bits; Flag 0 and Flag 1 may be controlled by the user via the internal software.

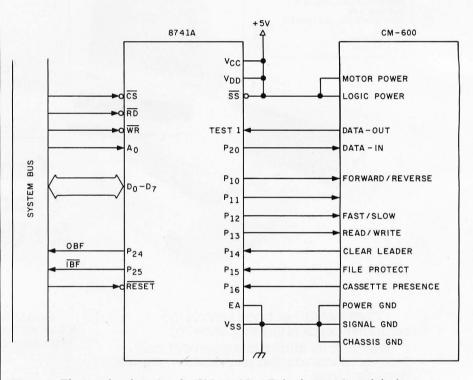


Figure 4: The interface between the CM-600 Mini-Dek, the 8741A, and the host system.

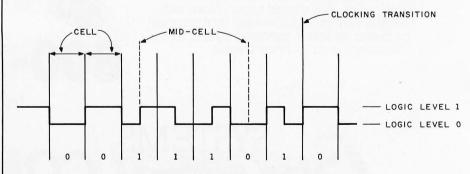
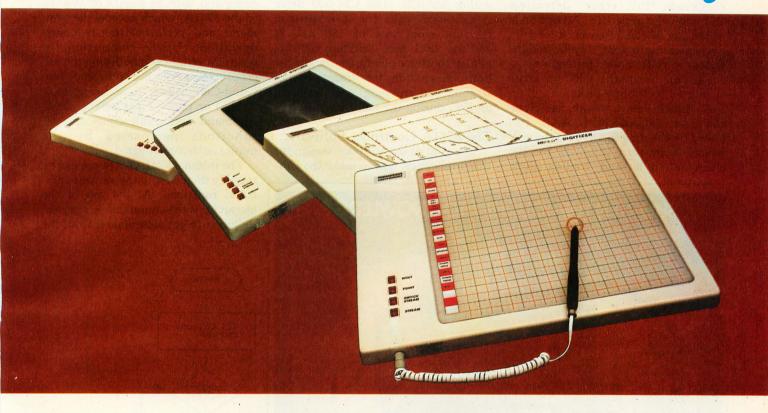


Figure 5: The hexadecimal character 3A phase-encoded. This is the algorithm used with the minicassette controller. It is not the logic level of a bit cell that determines its value, but the presence or absence of a mid-cell transition.

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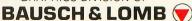
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Text continued from page 72:

scheme, the data format is also up to the user. The 8741A reads and writes blocks of variable length with an 8-bit checksum for error detection automatically appended. An option is to use the 8741A to check for errors by generating a CRC (cyclic redundancy check) code instead of a checksum, as in the CRC-16 error code used for floppy disks.

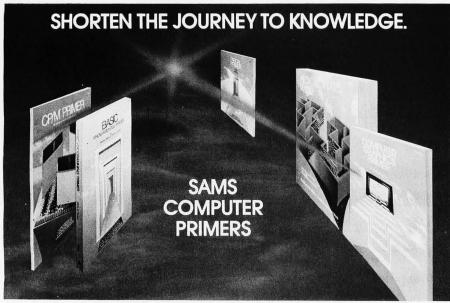
A block starts with a Sync character (hexadecimal AA), followed by the data (up to 64 K bytes), which is in turn followed by the checksum byte and trailing Sync

character. Blocks of data are separated by an IRG (inter-record gap). The IRG is such a length that the transport can stop and start within an IRG. The CM-600 drive specification calls for a worst-case start or stop time of 150 ms. A 450 ms IRG was selected for the 8741A to allow plenty of margin for both controlling the transport (ie: starting and stopping) and detecting an IRG during the SKIP operation.

The 8741A Controller Software

The goal of the software design for this application was to make the UPI- 41A microcomputer into an intelligent cassette-control processor. The host microprocessor (8085A, 8080A, 8088, etc) issues a high-level command such as READ or WRITE to the 8741A, which accepts the command and performs the requested operation. Upon completion, it returns a result code notifying the microprocessor of the outcome (eg: Good-Completion, Sync Error, etc). Table 1 on page 92 lists the high-level command and result codes for the functions performed by the minicassette controller.

The internal 8741A software can be roughly divided into the various command functions. At the top of the hierarchy is the command recognizer. Its job is to get a command from the



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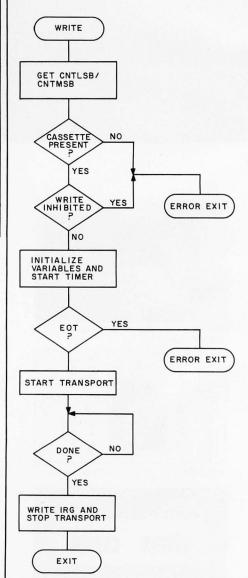


Figure 6: Flowchart of the WRITE command sequence.



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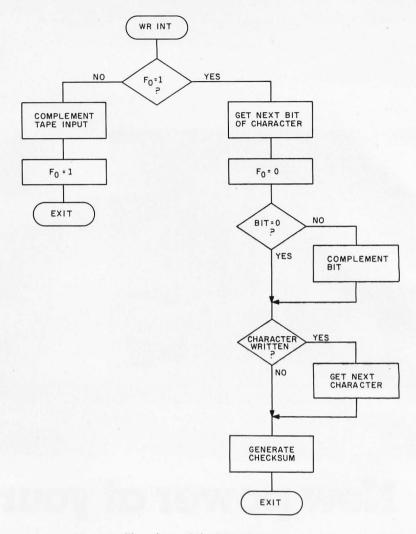


Figure 7: Flowchart of the WRITE interrupt routine.

microprocessor and branch to the appropriate command routine, executing until either the operation specified by the command is complete or aborted by the microcomputer or CM-600. The command routine then returns to the command recognizer to await the next command. Since only one command routine can be in execution at any one time, the working registers can change function based upon which command is active. These register names were assigned according to their function to aid program clarity. To understand the operation of the controller, let us examine the flow of the various commands in greater detail.

WRITE Command

When the WRITE command is issued by the microprocessor, the 8741A expects a 16-bit unsigned number specifying the number of bytes to be written onto the tape to

follow immediately. The controller requests only the desired number of data bytes by keeping track of the transfer count internally. All data transfers to and from the computer are double buffered. Before starting the transport, the 8741A checks the transport's status, verifying that the cassette is present and writing to the tape is not inhibited. If the drive is not ready for the data transfer, an appropriate error code will be returned; otherwise, the transfer will commence. The flowchart of this function is diagrammed in figures 6 and 7.

The controller begins the block transfer by writing a 450 ms IRG, followed by the leading Sync character, the data, the checksum character, and the final Sync character. The data is encoded with the phase-encoding algorithm described earlier before being written onto the tape. The internal timer is

Text continued on page 86

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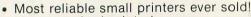
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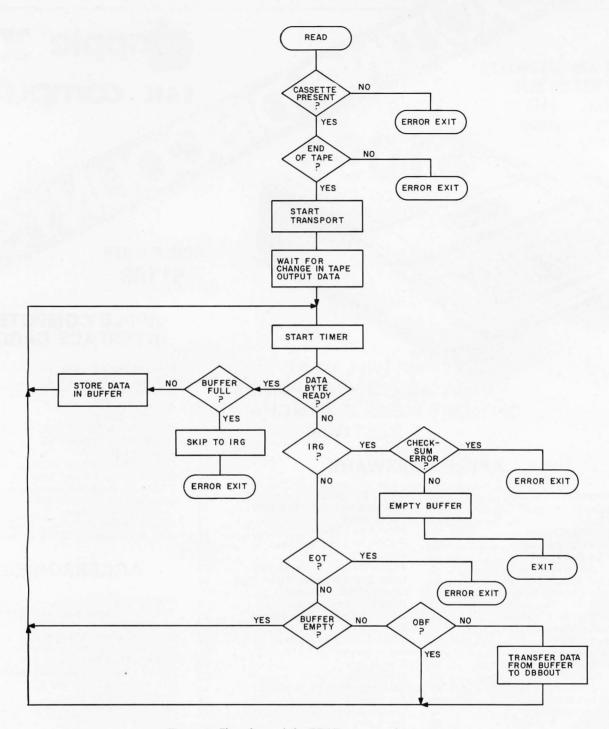


Figure 8: Flowchart of the READ command sequence.

Text continued from page 82:

used to signal both the initial cell transition and the mid-cell transition, generating an internal interrupt every 208 μ s. Thus, a byte is written every sixteen timer interrupts, or 3.3 ms. If nothing unusual happens during the operation, it returns a Good-Completion result code (hexadecimal 00) to the host.

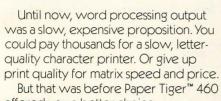
If an error occurs, the 8741A minicassette controller provides error

wrap-up facilities, protecting the information on the tape from being corrupted. For example, if the clear leader of the tape is found during a write operation, the transport is halted immediately. Another error results from the processor being late in supplying data to the controller, causing a data-underrun error and aborting the data transfer. A 450 ms IRG is then written onto the tape before the transport is halted.

READ Command

The READ command provides error checking similar to the WRITE command. Once the READ command is issued by the microprocessor, the controller checks for cassette presence and starts the transport. The data output from the transport is then examined and decoded continuously. This function is shown in the flowcharts of figures 8 and 9. The first character must be a Sync, or the

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Figure 9: Flowchart of the READ interrupt routine.

controller will abort the read operation, return a Bad-First-Sync result code (hexadecimal 42), and advance to the next IRG of the tape. If the Sync character is correct, succeeding characters are read into an internal 30-character FIFO (first-in, first-out) buffer, allowing the processor over 99 ms of service latency before a dataoverrun condition occurs. Whenever the DBBOUT register is empty, data is transferred to it from the FIFO buffer. This continues until an IRG is encountered, at which point the transport is stopped. The controller then tests the last character. If it is a Sync, the controller compares the ac-

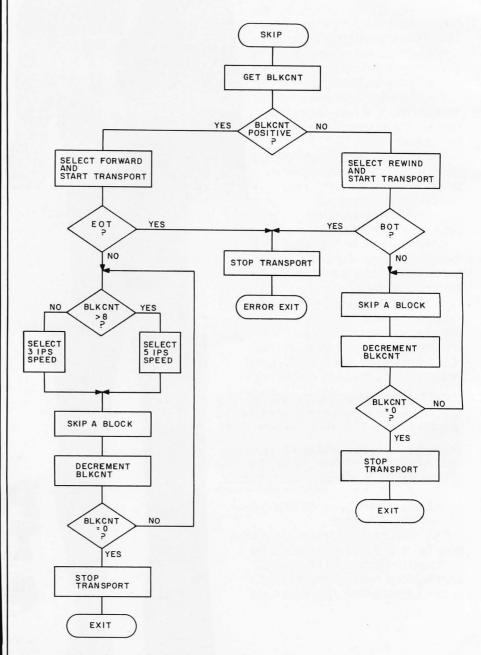
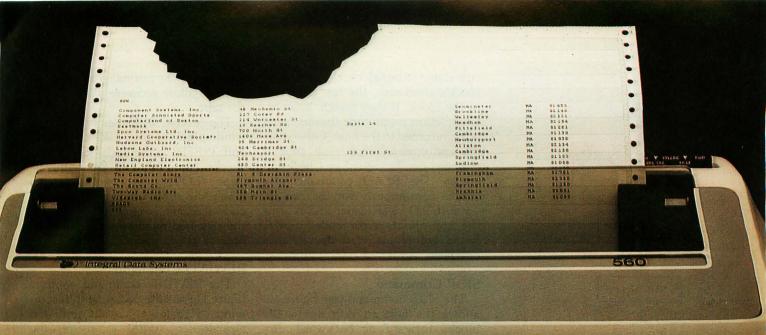


Figure 10: Flowchart of the SKIP command sequence.



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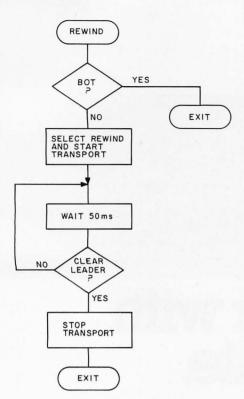


Figure 11: Flowchart of the REWIND command sequence.

cumulated internal checksum to the block's checksum, the last character of the block. If they match, a Good-Completion result code (hexadecimal 00) is returned to the host. Otherwise, the appropriate error-result code is returned (ie: Bad Sync2 or Checksum error). The READ command also checks continuously for the End-of-Tape (EOT) clear leader and returns the appropriate error code if it is found before the read operation is complete.

SKIP Command

The SKIP command (see figure 10) allows the host to skip up to 127 blocks forward or backward. Immediately following the command byte, the controller expects an 8-bit signed-magnitude byte specifying the number of blocks to skip. The most significant bit of this byte selects the direction of the skip (0=forward, 1=reverse). SKIP provides two search speeds in the forward direction. If the number of blocks to skip is greater than 8, the controller uses fast forward (5 ips) until it is within 8 blocks of the desired location, then

switches to the normal read speed of 3 ips to allow accurate placement of the tape.

The reverse SKIP uses only the rewind speed (15 ips). Like the READ and WRITE commands, SKIP also checks for EOT and Beginning-of-Tape (BOT) depending upon the tape's direction, returning an error code if either is encountered before the specified number of blocks have been skipped.

REWIND Command

The REWIND command routine, figure 11, sets the transport to fast rewind of 15 ips and waits until the clear-leader status input of the transport is active for more than 50 ms. (There is a hole at each end of the tape. It is guaranteed not to cause the clear-leader input to be active for more than 50 ms.) Once the clear leader is found, the CM-600 is stopped and a Good-Completion result code is loaded into DBBOUT.

ABORT Command

The final command, ABORT, is not a stand-alone command like the

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others. Instead, the ABORT function is part of each of the other commands, allowing the microcomputer to abort the current operation. If a command is found in DBBIN register during the operation of one of the

other commands, the command is compared to the ABORT command code. If it matches, the routine in execution is terminated. The Abort-Complete result code is then placed in DBBOUT to acknowledge the abort.

The aborted routine will, however, exit gracefully. An aborted READ or SKIP advances to the next IRG before terminating. An aborted WRITE command will record an IRG before terminating execution. This protection helps insure the integrity of data stored on the minicassette tape.

Conclusion

This application illustrates how the 8741A device can provide intelligent peripheral interfaces between a computer and a peripheral device such as the CM-600 Mini-Dek transport. This benefits the microprocessor system by divorcing it from the close management required by the peripheral. It interfaces to the 8741A controller producing a high-level I/O interface. The 8741A provides all the low-level peripheral-control functions. Another benefit of this task modularity is that it allows the software to be modified and upgraded without affecting the computer system software. In fact, the 8741A software could be adapted to control other cassette transports without affecting the microprocessor.

Command	Hexadecimal Representation	Result-Codes Returned	Hexadecimal Representation
READ	01	Good-Completion	00
		Buffer Overrun Error	41
		Bad Sync1 Error	42
		Bad Sync2 Error	43
		Checksum Error	44
		Command Error	45
		End-of-Tape Error	46
REWIND	04	Good-Completion	00
SKIP	03	Good-Completion	00
		End-of-Tape Error	47
		Beginning-of-Tape Error	48
WRITE	02	Good-Completion	00
		Buffer Underrun Error	81
		Command Error	82
		End-of-Tape Error	83

Table 1: Commands issued by the host processor and possible resultant codes returned to it when the EPROM in the 8741A is programmed with the software described in this article.

Omikron's Mapper + NEWDOS/80 8" Drives for the TRS-80

NEWDOS/80 is Apparat's latest upgrade to NEWDOS. Features include variable length records, chaining, and drivers specifically configured for Omikron's MAPPER II. \$150.

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WORD PROCESSING-MAPPER I supports professional word processors like the Magic Wand and Word Star (see reviews in June 80 Kilobaud). Omikron's implementation includes a blinking cursor, auto repeat, shift lock, debouncing, and an input buffer that eliminates missed characters. Magic Wand super discount price \$299.

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See review in July 80 BYTE By Jerry Pournelle.

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Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G	Call Call Call Call Call
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Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80	Call Call Call Call Call Call Call 22672 22955 \$420
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Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO	Call Call Call Call Call Call 22672 22955 \$420 \$620 \$923
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR	Call Call Call Call Call Call S2672 32955 \$420 \$620 \$923
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 RO	Call Call Call Call Call Call S2672 S2955 \$420 \$620 \$923
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 RO 5/55 KSR	Call Call Call Call Call Call S2672 S2955 \$420 \$620 \$923
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 RO 5/55 KSR Texas Instruments	Call Call Call Call Call Call 22672 22955 \$420 \$620 \$923 22684 33081 2863 3144
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 RO 5/55 KSR Texas Instruments 810 Basic	Call Call Call Call Call Call Call 52672 52955 \$420 \$620 \$923 \$2863 \$3144 \$1516
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 KSR Texas Instruments 810 Basic 810 Loaded	Call Call Call Call Call Call Call 22672 22955 \$420 \$620 \$923 22684 3081 22863 3144 31516
Centronics 737 Serial 737 Parallel Citoh Diablo Epson MX-80 MX-70 MPI-88G NEC 5510 5520 Okidata Microline 80 Microline 82 Microline 83 Qume 5/45 RO 5/45 KSR 5/55 RO 5/55 KSR Texas Instruments 810 Basic 810 Loaded	Call Call Call Call Call Call 2672 2955 \$420 \$620 \$923 2863 3081 2863 3144 31516 31739



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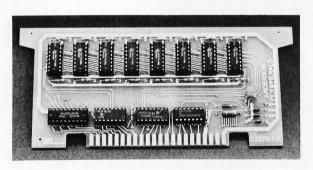
Software Review

A Reformatter for CP/M and IBM Floppy Disks

John A Lehman, 716 Hutchins #2, Ann Arbor MI 48013

In the "old" days of personal computing (ie: five years ago), the transfer of programs or data between large and small computers was not a major problem. You simply turned on the paper-tape punch in your Teletype ASR33 terminal and listed the program on the source computer. You then took the paper tape to the second computer, inserted it in the paper-tape reader, and read it in. This was slow, noisy, and did not encourage transfer of long programs, which microprocessor-based computers didn't have enough memory to run anyway.

The situation has changed quite a bit. Small computers are no longer mere experimenter's toys, but serious tools for science and business. Instead of being programmed only in machine language or BASIC, they are now programmed in FORTRAN, Pascal, PL/I, COBOL, and many other popular high-level languages. The fact that small machines can now run the same programs as the



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larger ones has increased the demand for program transfer between machines. For example, it is not uncommon for me to take a 1000-line FORTRAN program from a large timesharing system and run it (virtually unchanged) on my CP/M system. However, a program of that size is too large to dump to paper tape, even if any of the systems I use still had a Teletype terminal with a papertape reader.

This is where Microtech Exports' Reformatter for floppy disks comes in. IBM originally intended the floppy disk to be a replacement for punched-card data entry. The IBM 3740 Data-Entry System Basic Exchange Format (BEF) is a fixed-field, uncomplicated standard for data transfer between IBM equipment. Many machines that use floppy disks do not use BEF for normal use, because it is inefficient. However, almost all IBM equipment can use it to transfer files. Reformatter allows the transfer of data both ways between CP/M and BEF files.

Reformatter is a useful product for anyone who wants to take programs developed on one system and run them on another. For example, I have put a number of published FORTRAN packages onto my CP/M system. Going the other way, to avoid being charged for development time, I use my system to develop FORTRAN and PL/I programs to run on larger systems.

Another group who will find Reformatter useful are people with access to large computers that have peripherals they would like to use on a smaller system. For example, my CP/M system has neither 9-track magnetic tape nor a high-speed line printer, but I have access to an IBM Series/1 system that does.

So much for the motivation for using the Reformatter package. How does it work? Surprisingly well. It allows

At a Glance_

Name Reformatter

Translates between CP/M and IBM Basic-Exchange-Format floppy disks.

Manufacturer Microtech Exports

912 Cowper St Palo Alto CA 94301 (415) 324-9114

Price \$195

Format

8-inch floppy disk

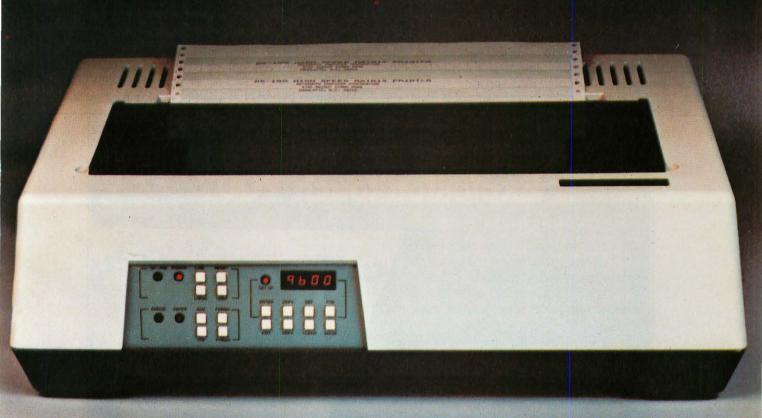
Computer

Any CP/M system and any IBM system. Requires two 8-inch disk drives.

Audience

Anyone with access to both CP/M and IBM systems.

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and many other features may be programmed and stored from the keypad. When your system is powered down, the format is retained in memory. The DS180 even remembers the line where you stopped printing. There is no need to reset the top of form, margins, baud rate, etc...it's all stored in the memory. If you need to reconfigure for another application, simply load a new format into the memory.

Communications Versatility — The DS180 offers three interfaces including RS232, current loop and 8-bit parallel. Baud rates from 110-9600 may be selected. A 1K buffer and X-on, X-off handshaking ensure optimum throughput.

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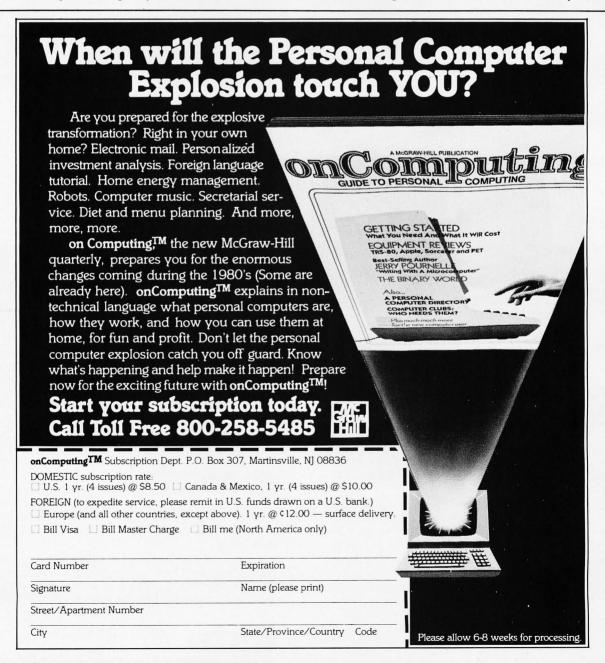
you to initialize Basic-Exchange-Format floppy disks, list their directories, change the file definitions, dump, display, edit, or delete the files, and to transfer data to and from CP/M files. Automatic character-set conversion and proper handling of conversion between fixed- and variable-record formats can be used or disabled. All of these functions work well and rapidly. Reformatter can transfer a file between CP/M and BEF twice as fast as an IBM Series/1 can transfer that same file to hard disk. Its file-manipulation facilities are also considerably more flexible than are the IBM-supplied versions.

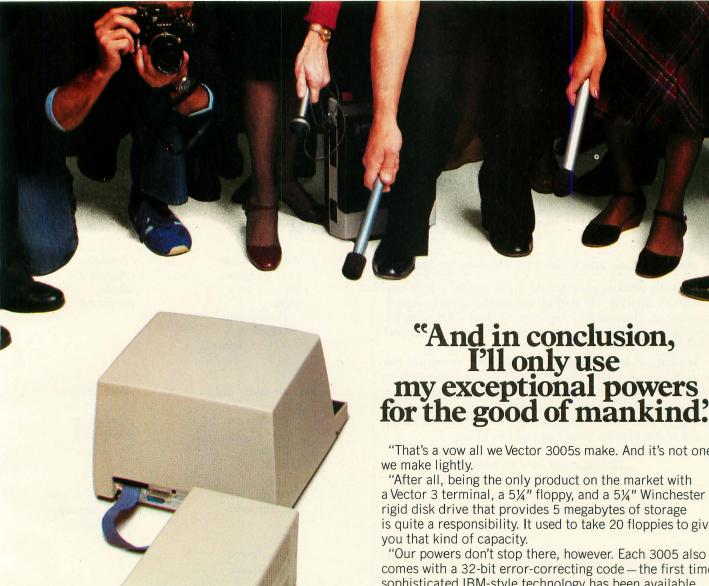
Reformatter is also easy to use. It is menu driven, and entering a carriage return at any point backs you up one level in the menu. In terms of ease of use, it ranks in the top quarter of the CP/M software that I have used, and in the top 1% of IBM software.

In fact, any problems I had using this package stemmed from IBM's tendency to do things the hard way from the user's standpoint. With any IBM software that I have used, you are required to specify the size of a file at the time you create it. On the other hand, CP/M can dynamically expand a file; moreover, it uses variable-length records, as opposed to IBM's fixed-length. The result is that you must specify the size of the IBM file without knowing the size of the CP/M file. There are a number of ways around this. You can set up your IBM disks with only one file per disk, which is not as wasteful as it sounds, since a BEF disk holds about 50 K bytes of text or programs (each line takes a full 128 bytes). The second solution is to purposely create overlapping files, copy them, check the directory for the resulting sizes, and repeat the process again. Finally, you can write a program that counts the lines in a CP/M file and tells you how many tracks and sectors the IBM disk will require.

In summary, if you have access to an IBM or an IBM-compatible computer system and you want your file- and data-transfer problems solved, Reformatter is probably what you've been looking for.

If you have a TRS-80 or access to DEC machines, Microtech Exports has another version for you.





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Technical Forum

MicroShakespeare Revisited or Kilobard

Andrew Kalnik, 3201 Wamath Dr, Charlotte NC 28210

William Shakespeare would have made a first-rate computer analyst. He had all the qualifications: superb powers of observation, capacity to deal with complex problems, imagination, and a fair ability to express himself.

Looking at his writings, you can easily recognize the vocabulary of a systems consultant making his pitch to land an installation contract. Presented in a conference room against a backdrop of easel charts, with gold-stamped proposal binders on the broad walnut table, some of his phrases would be right in place:

"...I'll teach you how to flow..."
(The Tempest, Act II, scene i)

"What is written shall be executed..."
(Titus Andronicus, Act V, scene ii)

"I will execute, and it shall go hard, but I will better the instruction..." (Merchant of Venice, Act III, scene i)

"...Our interpreter does it well..."
(All's Well That Ends Well, Act IV, scene iii)

From other lines, you can feel the sympathy the Programmer of Avon would give wretches like you and me sentenced to a debugging session:

"O hateful error, melancholy's child
Why dost thou show to the apt thoughts of man
The things that are not? O, error, soon conceived
Thou never comest into a happy birth..."
(Julius Caesar, Act V, scene iii)

Here's another short quiz to test how well you can match Master Will's golden words against the shiny silicon jargon of our art. (Try your hand at the other quiz in the April 1980 BYTE, page 104.) What we've done is to make free translations from Shakespearean phrases into terms familiar in computing.

Simply match the letter of the most pertinent modern phrase against the quotations. No prizes, just the satisfaction of puzzling out the answers. The answers and ratings are on page 184. [Editor's note: Each of the items 1 thru 20 will match to one of the answers "a" thru "t," so read through all the answers before you try to make a match. ...GW]

1. ()	We'll evaluate your purpose, and put on a form Troilus and Cressida, Act III, scene iii	a.	"And that crashed the whole program!"
2. ()	an adder did it A Midsum- mer Night's Dream, III/ii	b.	"We'll have the function graphed on screen in a few seconds."
3. ()	That one error fills him with faults. Two Gentlemen of Verona, V/iv	c.	"I wish I could check the reg- ister flags."
4. ()	shall run in a new channel fair and evenly I Henry IV, I/i	d.	"There isn't much time to convert the analog readings between inter- rupts."
5. ()	unpleasantest words that ever blotted paper The Merchant of Venice, III/ii	e.	"Put a scope or it to check those big input spikes."
6. ()	inferreth arguments of mighty strength III Henry VI, V/ii	f.	"With the new I/O board, it should just perk right along."
7. ()	the minute of	g.	"That frosts me

their plot is

almost come...

The Tempest,

-we're not get-

ting any output

from those

ANDs."

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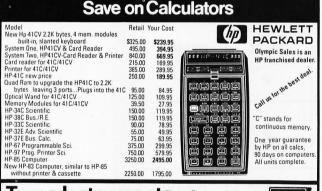
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Technical Forum.

8.	()	This fierce
			abridgement
			hath to it cir-
			cumstantial
			branches.
			Cymbeline,
			V/v

- h. "We regret to inform you that we can no longer supply replacement parts for your system."
- 9. () Look, what thy memory cannot contain/ Commit to these waste blanks. Sonnet lxxvii
- NOP
- 10. () ...full charactered, lasting memory... Sonnet cxxii
- "It was in aci. cumulator A."
- 11. () ...the very cipher of a function... Measure for Measure, II/ii
- "Looks like k. you're getting a hard-copy memory dump."

12. () ...Would I were 1 "If you have no assured of my more memory condition... left, you store King Lear. everything on IV/vii a scratch disk." 13. () ... Is it ended "Let's work up m. then...? a high-level Coriolanus. flowchart.' IV/iii 14. () ... The gates n. "We can't be made fast! any worse off." Brother, I like not this. III Henry VI, IV/vii 15. () O'erbearing "It seems you ο. interruption... can call a macro that in-King John, III/iv verts a 99 by 99 matrix." 16. () ...mark the high p. "It's unmaskable." noises... King Lear, III/vi



17. () What should that alphabetical position portend? Twelfth Night, II/v

"That IF-THENq. ELSE decision sequence cut the program down by at least 40%."

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18. () Thou hast caused printing to be used... III Henry VI, IV/ii

"Are we at step r. 9999?"

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19. () What I can do can do no hurt to try... All's Well That Ends

Well.

II/i

"ROM with complete ASCII set."

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99/4 console computer
Atari 800 16K computer console
Atari 1V Game
Mattel Intellivision TV Game
Mattel Intellivision TV Game
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20. () If it were done when 'tis done, then 'twere well/ It were done quickly... Macbeth,

"Can you tell me what this string is doing in position FFCA?"

t.

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Programming the Game of Go

Jonathan K Millen 661 Main St Concord MA 01742

Go is a board game. Like chess, it is a game of pure skill; moreover, a considerable body of literature has been devoted to it. Go was invented in China around 2000 BC. Since its introduction into Japan around 700 AD, it has flourished there to the extent that the most accomplished masters of the game are now Japanese. However, the game has spread world-wide. In the United States, one can find Go clubs in the vicinity of large cities and universities, and most large bookstores have at least one substantial book on the game.

Go is played on a 19 by 19 square grid having black spots on nine intersections, as illustrated in figure 1. The traditional board, called a Go Ban, is a wooden block about 17 inches square and several inches thick, with four short feet. It stands alone as a table at just the correct height for players sitting on floor cushions.

One player has a supply of black stones; the other, white stones. The stones are disks about the same size as the grid spacing; they are approximately three-eighths of an inch thick in the middle and almost sharp around the edge. The black stones traditionally are made of slate, and the white stones of clam shell.

Players move alternately, each

placing a stone on the point of intersection of a pair of grid lines. The object of the game is to enclose the most area, measured by the number of unoccupied points enclosed by stones of a given color. A point is enclosed by, say, black, if no path along the grid from the point runs into a white stone. Figure 2 shows some enclosed areas. Note that the edge of the board can form one boundary of an area.

A player can increase his area by capturing the opponent's stones. Stones are captured a connected group at a time. A set of stones forms a connected group if there are paths along the grid from any stone to any other stone in the set, such that all points on the path are occupied by stones in the set. This criterion is easy to visualize because the stones, being as large as the grid spacing, actually touch along paths of connection. The phrase "connected group" also implies that the stones in the group are all of the same color, and that the group is not merely a part of some larger connected group.

A group of stones is captured when it has no liberties. A liberty of a connected group is an unoccupied point adjacent (vertically or horizontally) to a stone in the group. If a group has just one liberty, the opponent may capture it by placing one of his stones

on the liberty. The opponent then picks up the captured stones and keeps them as prisoners. At the end of the game, a player's point count of area is augmented by the number of prisoners he has captured. Figure 3 shows a group having one liberty.

The game ends when both players pass consecutively, because they both see no further advantage in playing more stones. Usually, when this happens, there are white stones within areas enclosed by black, and vice versa. These stones have been given up because the owner can predict that they will be captured. They are removed as prisoners at the end of the game before counting the score.

The remaining rules are technicalities. Two that have a significant effect on the game, concerning "ko" and "suicide," will be mentioned later on. The rest involve details of ending the game and scoring, and are rarely invoked.

A Go-Playing Program

A Go opponent, called Wally, was programmed on a KIM-1 within its approximately 1 K bytes of memory. Wally's algorithm is based on essentially two capabilities: finding the liberties of a connected group, and matching a few common patterns. Moves take less than a second.

A 15 by 15 board was used because

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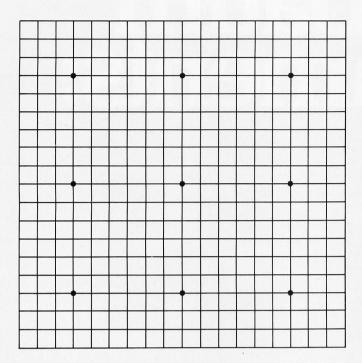


Figure 1: The Go board. Players move alternately, placing stones on the points of intersection of the lines, rather than in the spaces. The nine dots are handicap-stone locations. The line spacing is about 2.2 cm (seven-eighths of an inch).

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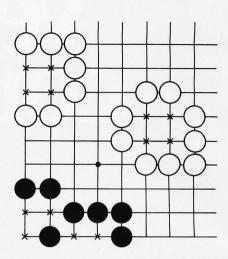


Figure 2: Enclosed areas. Points marked x are in areas enclosed by one player or the other. The figure shows five black points and eight white points.

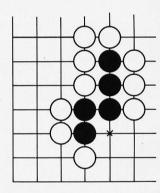


Figure 3: A black group with exactly one liberty, marked x. If it is white's turn, he can capture the black group by placing a stone at x and removing the black group as his prisoners.

it was convenient for addressing reasons to represent it internally within a single 256-byte page, using one byte per point. Although there would be room for a 16 by 16 board, a Go board ought to have a center point. Rows and columns were numbered from 1 to F (in hexadecimal) so that the coordinates of a move could be entered on the KIM keyboard.

When a move is entered, Wally responds with the coordinates of his move on the KIM display, and the complete board is also output on a video terminal. The display of a game in progress is shown in photo 1.

Once the board representation and the input and output routines were set up, the first major component of the



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program to be written was the routine that walks through a connected group of stones, marking the members of the group, and both marking and counting its liberties. Called COUNT, this routine is a variety of the maze-search algorithm. It was programmed recursively in machine language.

What COUNT does for each board location it looks at is based on the "invariant assertion" that any point it looks at is one of the following:

- a stone in the connected group
- a liberty of the connected group
- a stone of the other color adjacent to the connected group

If it is looking at a stone in the group, it checks to see whether that stone has previously been marked. If not, it marks the stone and calls itself to repeat the same process, starting with each of the four locations north, east, south, and west of the present stone.

Marking a stone or point, of course, means to set a particular bit in the byte corresponding to that point in the board representation. Other bits encode whether the point is

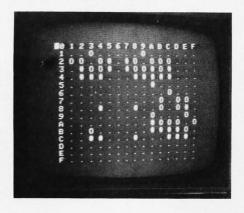


Photo 1: A game in progress. Wally (the computer) is playing black, represented by the solid-looking crosshatches (#). The author is playing white, represented by 0s. The computer uses a 15 by 15 board; the points of play are indicated by periods. In this game, black was given a nine-stone handicap.

occupied and, if so, by what color stone.

If COUNT is looking at an unoccupied point, it marks the point as a liberty and increments the count of liberties, unless the point has already been marked and counted.

If COUNT is looking at a stone of the other color, it does nothing, and just returns.

If a stone is on the edge, or first line, of the board, then one (or, in a corner, two) of its neighbors will be off the board. If COUNT is called for an off-board location, it returns immediately.

Note that, if COUNT starts on a stone and operates as described above, the recursive calls to COUNT will carry the center of attention all over the group and onto all neighboring points. The invariant assertion is satisfied because COUNT progresses one step each time only from stones in the group, as sketched in figure 4.

The algorithm for COUNT is specified concisely in listing 1 using a kind of "structured English." The rest of the Go-playing program will be specified similarly, as a collection of modules like COUNT.

Recursion is not difficult to implement; COUNT just calls itself with the usual jump-to-subroutine instruction for each of the neighboring points. The current board location is in a register; it is saved on the KIM stack before it is replaced by the location of each neighboring point, and then restored upon return from each call. The size of the connected group

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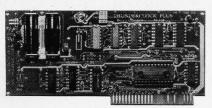
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is limited by the size of the stack; one byte of board location plus two bytes of return address are pushed for each call, and the calls are nested as the algorithm "walks" around the group. A 100-byte stack can handle a 33-stone group. A group of that size would occur, if at all, only near the end of the game, when Wally's play deteriorates for other reasons anyway.

Main Loop

After COUNT was coded, a reasonable overall structure for a program to use it followed quickly. The main loop is specified in listing 2. The "consequences" of counting a group of stones include removing it from the board (zero out the board locations) if it has no liberties; other consequences have to do with suggesting tentative moves for Wally. Wally always plays black, in accordance with the Go tradition of giving the black stones to the weaker player.

The pattern-matching facility was not implemented immediately. In fact, the first version of the program chose black moves randomly, trying again if it hit upon an occupied point.

At least the capturing of black groups could be tested, and, for the most part, it was playing legal Go.

Tactics and Priorities

The next step in the design of the program was the decision that Wally would make contact moves, adjacent to white stones. In this way, the program would appear to be attempting to capture white groups, and would eventually fill up the liberties of each white group and capture it, if no defensive action were taken.

At the same time, it was clear that Wally also should take some defensive moves to avoid capture. This brought up the question of priorities: when is a black group threatened enough so that Wally should stop attacking white and make a defensive move instead? The answer had to be based on the number of liberties remaining in the black and white groups. It was decided that threats would be ignored until a black group had been reduced down to one or two liberties. Otherwise, Wally attacks whichever white group has the least number of liberties, because that group promises the best chance of being captured.

This strategy was implemented by associating a number of liberties with each suggested black move-namely, the number of liberties remaining for the group contacted by the stone. When a move is suggested, such as some liberty of a white group being

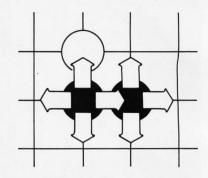


Figure 4: How the procedure COUNT works. When tracing a black group, COUNT begins on a stone in the group and calls itself recursively to look at the four neighboring locations. If a neighbor is a black stone, the process is repeated until all stones in the connected group have been found. All unoccupied points adjacent to stones in the groups (ie: liberties) are also found and counted.



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Listing 1: Structured English specification of COUNT module to find and count the liberties of a connected group containing a stone at point "x" of color "color." COUNT calls itself recursively, saving x on the push-down stack during each call.

```
COUNT(x, color):
  IF x is not off the edge
  THEN
    IF there is a stone at x AND
      it is the given color AND
      it is not marked
    THEN
       mark it
        CALL COUNT(NORTH(x), color)
        CALL COUNT(EAST(x), color)
        CALL COUNT(SOUTH(x), color)
        CALL COUNT(WEST(x), color)
    ELSE IF there is no stone at x
    THEN
       mark the point as a liberty
       increment the liberty count
   END
```

END

counted, a best (move, liberties) pair is updated if the new move is adjacent to a group of a smaller or equal number of liberties. Since black groups are counted after the phase in which white groups are counted, a move by black in contact with a black group with one or two liberties is automatically preferred to a move adjacent to a white group with the same number of liberties. An exception was put in later: when Wally finds a chance to capture a white group on the next move, he always takes it, even if some black group also has only one liberty. There is some doubt whether this exception was wise, however.

Ko and Illegal Moves

There are two situations in which a

move on an unoccupied point is illegal. A move that leaves one's own group with no liberties is illegal. Figure 5a shows a move by black that would be illegal because the resulting black group would have no liberties. A move resulting in the capture of an opponent's group, as in figure 5b, is permissible because removing the captured group creates at least one liberty.

The second type of illegal move arises from a ko, illustrated in figure 6a. If white captures the central black stone on his next move, the position will look as in figure 6b. Now black can capture the white stone and reproduce the original position in figure 6a. This could go on forever. To prevent such infinite repetition, the Rule of Ko was introduced: no

Listing 2: Module specification for the main loop of the Goplaying program and two of its called modules.

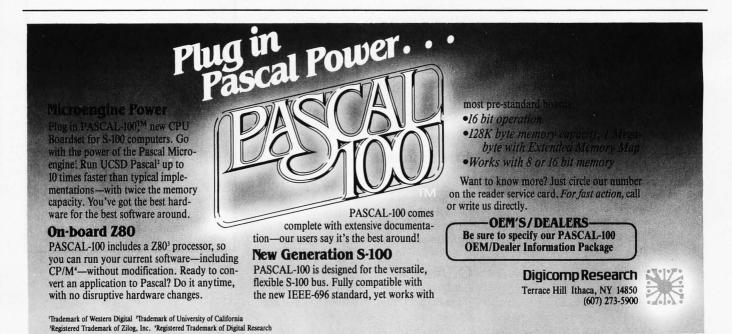
```
MAIN:
place black handicap stones
LOOP
display the board
get white's move from keyboard
CALL WEFFECT for the effect of white's move
CALL BEFFECT to obtain a tentative black move
CALL PATS to check for a pattern match
place black stone
END

WEFFECT:
FOR each point x with a black stone DO
CALL COUNT(x,black)
IF the group has no liberties
```

ELSE IF the group has at least one liberty

THEN remove its stones

THEN choose a liberty not on edge line IF the group has 1 or 2 liberties THEN CALL EVAL for the chosen liberty **END** END BEFFECT: FOR each point x with a white stone DO CALL COUNT(x, white) IF the group has exactly 1 liberty THEN designate it as the black move remove the white stones EXIT ELSE IF the group has 2 or more liberties THEN choose a liberty CALL EVAL for the chosen liberty **END** END



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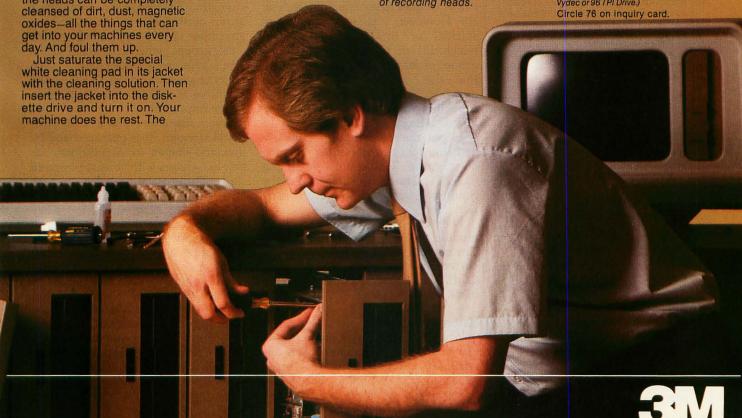


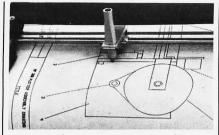
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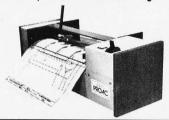
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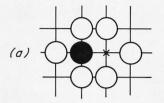
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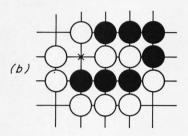
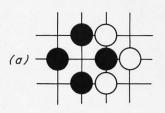


Figure 5: Illegal moves. The point marked x in 5a is illegal for black because it would result in a black group with no liberties. The point marked x in 5b is permissible, however, because it captures the two white stones, leaving the inner black group with two liberties.



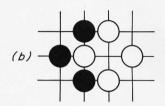


Figure 6: Ko. In 6a, white can capture the black stone, resulting in 6b. It is illegal for black to restore 6a immediately by recapturing the white stone; he must wait a turn

player may move so as to reproduce the board position existing just prior to his opponent's last move. A move must be made elsewhere to change the board position before the ko capture is allowed.

Lookahead

Kos are common and often critical in master games, but at Wally's level it was simpler to leave out the Rule of Ko. However, it is essential to avoid suicidal or totally wasted moves which fill in the last liberty of a group, or leave it only one liberty, so that the group will be captured anyway. Hence a limited lookahead capability was adopted. The last step in evaluating a suggested black move is to put the stone down tentatively and count the liberties of the resulting black group. This is done by calling COUNT. The move is rejected if the resulting group does not have at least two liberties.

The complete move evaluation module, EVAL, is shown in listing 3. The module LOOKAHEAD saves the current (move, liberties) pair before COUNT is called with the tentative black stone in place.

Pattern Matching

Wally's most intelligent-looking moves are pattern matches. There are common configurations of stones which suggest an obvious next move to a good player. Wally has a table of patterns of this sort; these patterns are illustrated in figure 7. Each pattern includes one white stone and two black stones, with a third black move indicated. Patterns 7a thru 7e represent responses to threatened connections. Patterns 7f and 7g create good "shape."

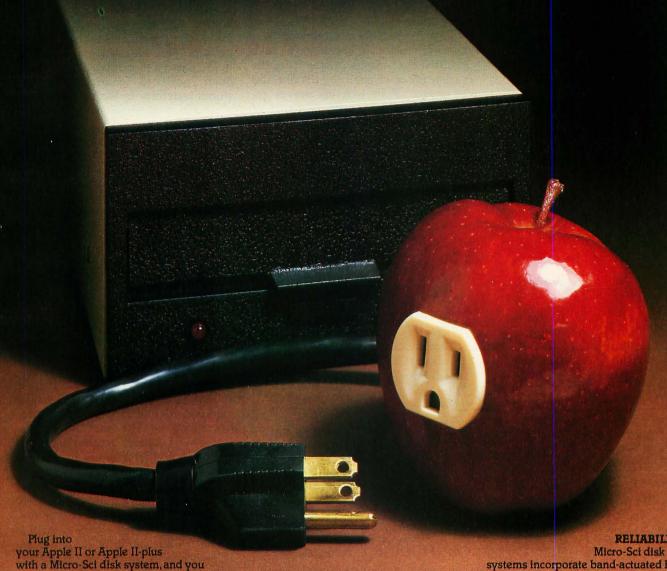
In Go, as in other spheres, there is truth to the motto, "In unity there is strength." The first step in capturing a group of stones is to cut it off from any other large groups nearby. Two weak groups, when connected into a single large group, often have a much better chance of survival. That is why defensive moves like figures 7a thru 7e are important.

Good *shape* in Go is a local positional strength. It is characterized by diamond-shaped configurations, or box-like shapes with at least two solid walls. These patterns enclose an area in an easily defended way, and serve as a basis for expansion. Moves like those in figures 7f and 7g are aggressive moves that take area while expanding against the opponent's outposts

outposts.

The program looks at each white stone, trying to find two black stones near it in the same relative positions as in one of the patterns. The table entry for a pattern contains the vertical and horizontal displacements of the two black stones relative to the white stone, and that of the suggested black move. If the two black stones

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are found and the point for the black move is unoccupied, the black move is returned for evaluation.

Each pattern must be considered in all possible orientations around the

Listing 3: Module specifications for move evaluation, lookahead, and pattern matching.

EVAL(move, liberties):
GLOBAL (best-move, best-liberties)
IF liberties ≤ best-liberties AND
LOOKAHEAD(move) ≥ 2
THEN
best-move = move
best-liberties = liberties
END

LOOKAHEAD(move):
place black stone at move
CALL COUNT(move,black)
remove black stone
RETURN count of liberties

PATS:
FOR each white stone DO
IF there is a pattern in the table
centered on that white stone
THEN
get suggested black move y
CALL EVAL(y,2)
EXIT
END
END

white stone. Three-stone patterns have either four or eight orientations, depending on their lateral symmetry. The program trades table space against program space by performing 180° rotations automatically. Thus, two or four table entries representing different orientations of each pattern are needed to account for all possibilities.

Pattern matches are checked last, because they almost always take priority over moves arising from the earlier phase of counting the liberties of groups. Pattern-match moves are associated with an artificial figure of two liberties to set their priority. Thus, if Wally can capture a white group, or avoid the capture of a black group having one liberty, he will do so despite any pattern matches. The priorities of the patterns are determined by the order in which they are checked, since the first match found is returned.

Ghost Stones

The edge of the Go board is strategically important because it helps to wall off areas. An attempt by white, for example, to invade be-

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tween a black stone and the edge of the board should be defended against. The first five patterns in figure 7 already defend against threatened connections; why not use them to protect the connection between a stone and the edge of the board? Imagine that there is an additional row of black "ghost" stones all around the board. As figure 8 shows, a white move near the edge can then invoke a pattern. This idea was implemented in the pattern match by allowing off-board positions to count as black stones tested for in each pattern.

Edge Moves

One of the most startling improvements in Wally's performance resulted from a simple observation in the first few games. Groups on the edge of the board, when attacked, often extended fruitlessly along the edge, as in figure 9. A prohibition against edge moves, except to capture or on a pattern match, was added. Wally's play began at that moment to take on the character of an opponent to be reckoned with.

Handicaps

Go has a handicap system that allows an expert to play an even and interesting game with a novice. Black is given a head start of two to nine stones on designated points—the ones marked with black spots on the board (see figure 1). The handicap stones are placed symmetrically like die spots, except that a handicap of three stones is placed on three corners. Additional handicap points, for a total of up to seventeen stones, were added for Wally's benefit, since it was not expected that he would be a strong player. Each additional handicap stone accounts for roughly 10 points difference in score.

The handicap stones help to make up for Wally's lack of overall strategy. The handicap points are good points to occupy early in the game, so a large handicap solves much of the strategy problem.

Eyes and Life

Wally has a blind spot that costs him dearly against experienced players: he does not understand that any group, no matter how large, will be captured unless it has two "eyes," or sufficient space to make them. An eye is an unoccupied point or connected group of points. A group enclosing two eyes is immune from



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Figure 7: Patterns. In each of these seven configurations, the black move marked x is suggested when the white stone and the two other black stones are already present. These patterns are applied in all orientations.

capture, because a group cannot be captured unless it can be brought down to only one liberty. A group with two eyes will always have at least two liberties. The opponent cannot fill either eye because such a move would fill all the liberties of his invading stone, and hence is illegal. Figure 10 illustrates this.

Wally does surprisingly well despite a fundamental ignorance of the facts of life. Captures and patternmatching moves tend to create eyes more or less automatically.

Play Experience and **Improvements**

Wally plays like a beginner; however, he does play better than people just introduced to the game. Experienced players are surprised by the reasonableness and apparent skill of some of Wally's moves but are quick to discover that he does not know about forming two eyes.

Along the present lines, there is no room for significantly improving Wally within the 1 K-byte memory that my KIM-1 has. With a memory extension, the first improvement that springs to mind for the future is a fullsized board. The Rule of Ko is not hard to implement and should be included. Many more patterns ought to be added, and the pattern-matching mechanism could be more general.

Wally should be taught something about ladders, if only to avoid them. A ladder, illustrated in figure 11, is a sequence of moves that ends in disaster for one side or the other, depending on conditions several moves ahead.

The most challenging problem for a Go-playing program is how to recognize when a group does or does not have the potential to form two

Looking ahead down the move tree as a general approach, as is done in chess-playing programs, has two obstacles: the sheer number of possible moves at each turn, and the need to first develop a way to evaluate the board configuration. The best candidate for an evaluation function is

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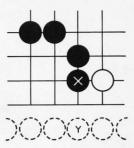


Figure 8: Ghost stones. The black move at x is suggested by the pattern in figure 7d because there is an imaginary black stone at point Y, off the edge of the board, for purposes of pattern matching.

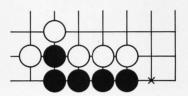


Figure 9: Running along the edge. Before the program was modified, black would move at x, white could respond just above x, and the process would be repeated until the black "worm" reached the edge of the board and was captured. Edge moves are now prohibited except for captures and pattern matches.

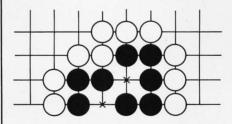


Figure 10: A safe group with two eyes. White cannot capture black because both eyes, marked x, would have to be filled. But white can make only one move at a time, and a move in either point is illegal.

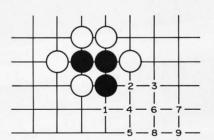


Figure 11: A ladder. White threatens to capture black by moving at 1. When black attempts to escape at 2, white moves at 3, and so on. The black stones form a staircase that eventually reaches the edge of the board and is captured by white 9. If there were a black stone at 6, however, black would escape, and white would be left in a vulnerable position.

an estimate of the area controlled by each player. When an area is only loosely surrounded, however, or an invasion is in progress, it is very difficult to determine the ownership of many points. A possible approach is the perceptual-grouping heuristic method developed by Zobrist (reference 3). Move tree searching is probably the only way to find the best move in confined tactical situations, like those that appear in Go problem books.

Another improvement suggested by chess programs is to include some of the countless known corner openings, or "joseki." Joseki are useful anywhere in the board, and should be implemented as an extension of the pattern matching.

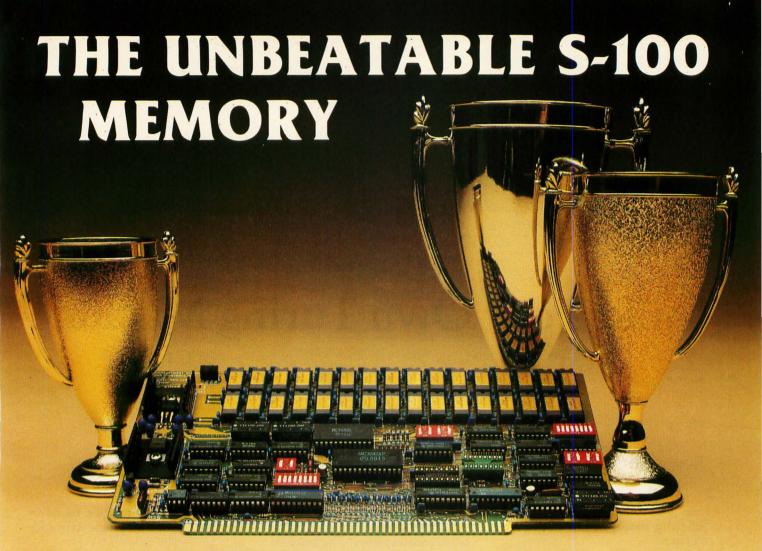
After a move that leaves an opponent's group with only one liberty, one is supposed to say "atari" to warn him that his group is about to be captured. Wally says nothing, and I have lost large groups by failing to notice an impending capture. "Atari" goes in next.

References

- 1. Ryder, J. "Heuristic Analysis of Large Trees as Generated in the Game of Go." Stanford University: Ph D Thesis, 1971.
- 2. Wilcox, B. "Computer Go." American Go Journal, 1979.
- 3. Zobrist, A. "A Model of Visual Organization for the Game of Go." AFIPS Spring Joint Computer Conference, 1969, pages 103 thru 112.

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Build Your Own Turing Machine

James E Willis Lawrence Berkeley Lab 1 Cyclotron Rd Building 4 Berkeley CA 94720

In 1936, Alan M Turing gave the following description of a computing machine:

The machine is supplied with a "tape" (the analog of paper) running through it, and divided into sections (called "squares"), each capable of bearing a "symbol." At any one moment there is only one square, say the rth, bearing the symbol G(r) which is "in the machine." We may call this square the "scanned square." The "scanned symbol" is the only one of which the machine is, so to speak, "directly aware." However, by altering its m-configuration, the machine can effectively remember some of the symbols which it has "seen" (scanned) previously. The possible behavior of the machine at any moment is determined by the m-configuration g(n) and the scanned symbol G(r). This pair g(n), G(r) will be called the "configuration." Thus, the configuration determines the possible behavior of the machine. In some configurations in which the scanned square is blank (ie: bears no symbol) the machine writes

down a new symbol on the square; in other configurations, it erases the scanned symbol. The machine may also change the square which is being scanned, but only by shifting it one space to right or left.

A Turing Machine consists of three parts: a tape, a program, and a device.

Turing's description has become the definition of computability. That is, if a Turing Machine can work the problem, then the problem is said to be computable. If no Turing Machine can eventually find an answer to the problem, then the problem is not computable. John von Neumann and others have tried to establish a relationship between a Turing Machine and human neural networks. (See Michael Arbib's book, listed in the references at the end of this article.) An overview of these concepts along with some history of the problem is given in an article by Jeremy Bernstein (reference 2). An example of a

hardwired version may be found in Jonathan K Millen's article (reference 3).

As with other problems involving computing machines, the first step is to carefully define the problem or task. Once a careful definition has been given that defines and limits the scope of the project, we may then attempt a solution. The solution may take on many forms depending on the intended use of the project.

In this article, I will describe a finite (theoretical) Turing Machine (TM) and the implementation of a Practical Turing Machine (PTM) in hardware, in a program for the 6800 microprocessor, and in a FORTRAN program. These implementations are equivalent in that they accept the same input and, for that input, produce the same output.

Turing Machines—a Definition

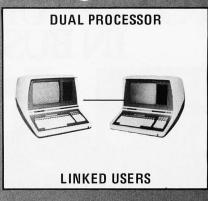
A Turing Machine consists of three parts: a tape, a program, and a device. The tape consists of an infinite array of 1s and 0s. The device writes on the tape and moves the tape according to the program. (See figure 1a.)

Text continued on page 128

igurability









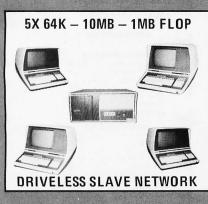
















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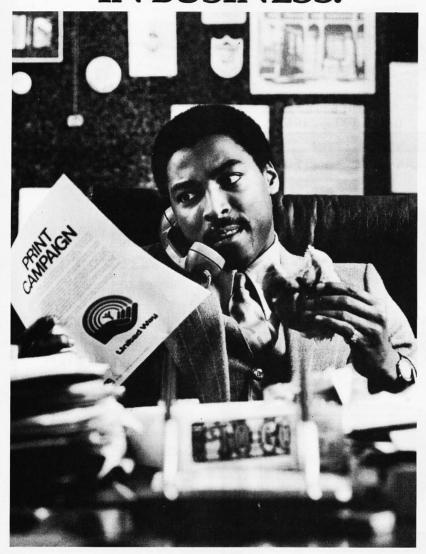
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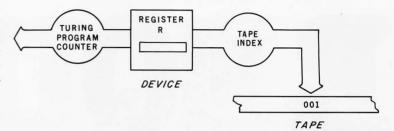
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		NUMBER	w	D	ADR	COMME			
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1	0	1	3	1	1	4	CHECK SECOND BIT		
2	0	1	4	1	1	3			
3	1	1	5	1	1	5	WRITE A 1		
4	0	1	5	0	1	5	WRITE A O		
5	0	0	6	1	0	6	LOOP TO 6		
6	0	1	5	1	1	5	LOOP TO 5	5 (HALT)	



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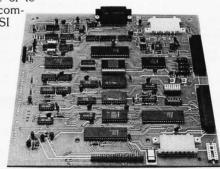
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(1b)START READ FIRST FVFN YFS NO READ NEXT READ NEXT EVEN EVEN NO PARITY PARITY YES YES WRITE WRITE STOP

Figure 1: Model of a Turing Machine and an example. Figure 1a presents a symbolic representation of a Turing Machine divided into three principal components: a program, a tape, and a mechanism or device for executing the program. The current instruction being executed is pointed to by the Turing program counter (TPC), the register R holds the contents of current tape position. The index I points to the character that is currently under the tape head. The program given in figure 1a reads 2 bits from the tape and writes a third bit to give the three characters odd parity (an odd number of 1s among them). The program has an initial state given by statement 0 and a final or halting state given by the infinite loop of statements 5 and 6. The flowchart in figure 1b shows the logic of this program, with the numbers beside each box being the statement number associated with that position within the flowchart.



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The device first reads position *I* of the tape through the tape head, then places the value it finds into its register, R. If R contains a zero, the device executes the left side of program statement number Turing Program Counter (TPC). If R contains a 1, the device executes the right side of program statement number Turing Program Counter.

Each side of each program statement contains a value for the variables W, D, and ADR. The symbol W indicates what is to be written on the tape. The symbol D indicates the direction to move the tape head: if D=0, the tape head is moved one space to the left; if D=1, the tape head is moved one space to the right. The symbol ADR is the address of the next program statement to be executed. Briefly, the device reads the tape, writes on the tape, moves the tape head, and transfers control to another program statement. The program presented in figure 1b is a parity checker-that is, the machine reads two binary digits and writes a third to

give the total 3 bits an odd number of 1s—that is, odd parity.

[It should be noted that the previously mentioned notation for a Turning Machine is not the one usually encountered in classrooms and textbooks. A more formal definition defines a Turning Machine with the program expressed as a set of 5-tuples of the following form:

(current state, character being read, character to write over current character, next state, direction to move tape)

where the particular 5-tuple to be applied is the one that is given by the current state and the character being read. It can be seen that each line of the notation used in this article can be rewritten as two 5-tuples of the above form; therefore, the two notations are equivalent GW]

The operation of a Turing Machine may be represented by a flowchart, as in figure 2. Suppose that the variables W, D, and ADR are contained in

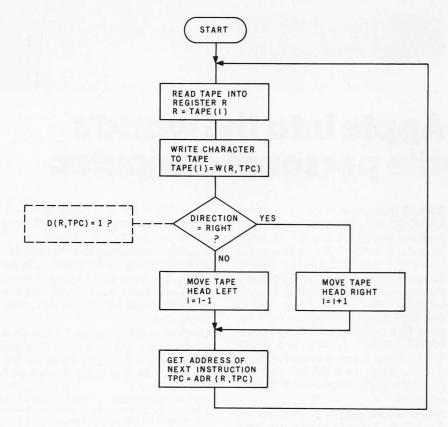


Figure 2: Flowchart for the Turing Machine algorithm. In this algorithm, written primarily for a hardwired or assembly-language implementation, the only allowable characters that can be written are 0 and 1. The only allowable movements for the tape head are left and right. The algorithm does not end as such, but a final or halting state can be implemented by the addition of two program lines that unconditionally loop to each other, denoting the end of the algorithm. This is done in the example of figure 1a.

three arrays, each two-dimensional: W(R,TPC), D(R,TPC) and ADR (R,TPC). The first subscript corresponds to the value contained in register R, while the second subscript refers to the program statement number. (In the example of figure 1, W(1,3) = 0, D(1,3) = 1, ADR(1,3)=3.) The variable I refers to the position of the tape. Hence, the tape is represented by a one-dimensional array, TAPE(I). The variable TPC represents the Turing program counter—that is, the line of the Turing program being referenced. These variables, along with the description. of the operation of a Turing Machine, are utilized in the flowchart of figure

So far, no restrictions have been placed on the values of TPC or the tape index I. Turing assumed that the program and tape were indefinitely large. In a practical Turing machine, the variable TPC takes on values up and including the maximum number of program statements. The tape index I may take on values up to and including the number of spaces on the tape. It is usual to assume that when the value of *I* exceeds the length of the tape, it returns to the first position on the tape, so that the tape then becomes finite and connected to form a loop. We call such a restricted machine a practical Turing Machine (PTM). With these restrictions it is possible to construct a PTM from discrete digital components.

A Hardware Version

A hardwired version of a PTM utilizing integrated circuits can be readily constructed as described in the Millen article (see reference 3). In the present implementation, the program is stored in a 128 by 8-bit programmable memory circuit. (See figure 3.) The variables are the same as those used in the flowchart. The temporary register holds the value of ADR(R,TPC). Register TPC points to a program statement. Register R selects the left or right side of the program statement. The value of *I* is held in a 12-bit binary up-down counter. The tape is represented by 4096 bits of programmable memory. The boxes labeled "address selector" operate like double-throw switches and facilitate loading and execution of programs. A maximum of sixtyfour program statements may be

Text continued on page 136



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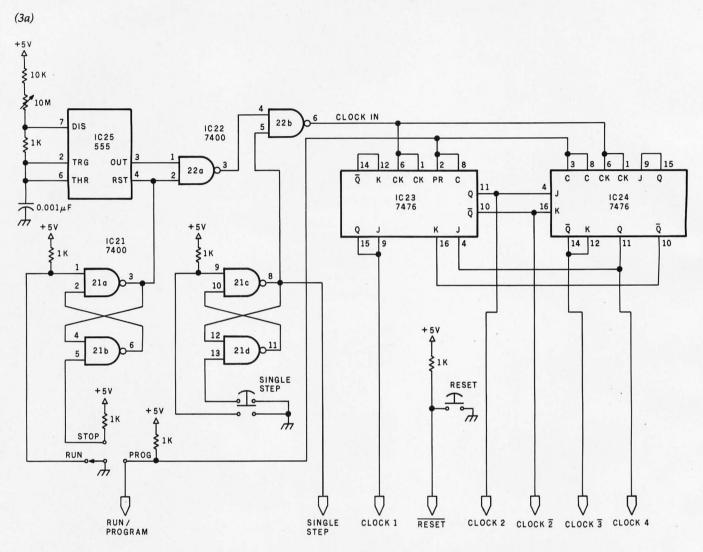


Figure 3: Schematic diagram for the hardwired Practical Turing Machine. The device is designed to be built on three small circuit cards, figures 3a thru 3c. In figure 3a, the clock board, IC23 and IC24 produce a four-phase clock used by the other boards.



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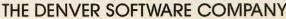
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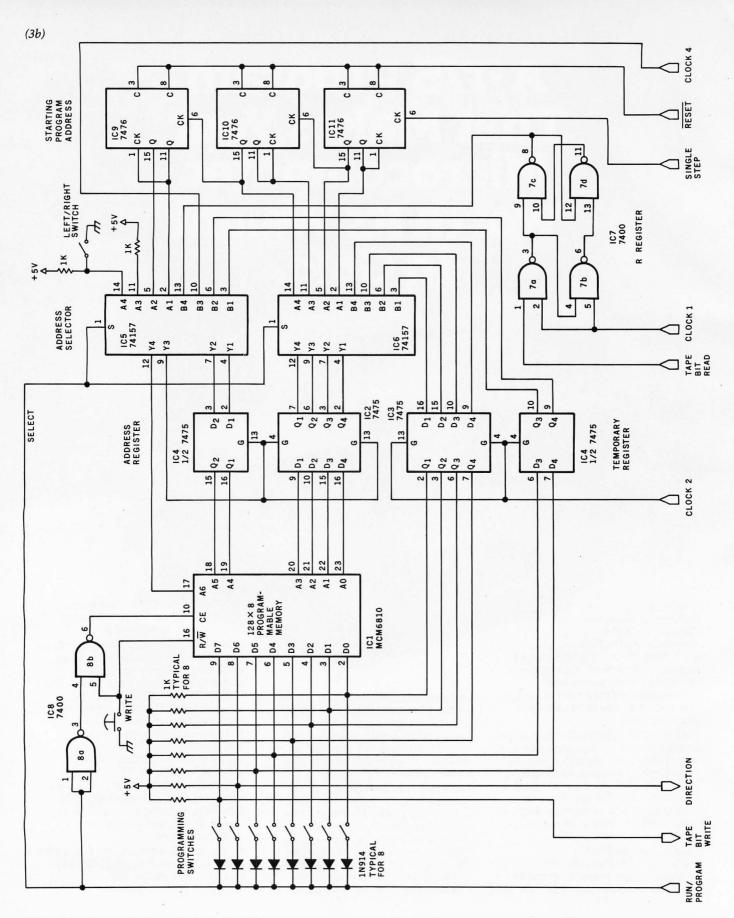


Figure 3b: The processor card. IC1 is the Turing program memory; the lines coming into A0 thru A6 of IC1 are the Turing Program Counter (TPC). IC7 stores the R (direction) bit, and IC9, IC10, and IC11 store the Turing program address at which the program will start execution. The left/right switch designates which half of the Turing program word is written (switch open = left half) when the RUN/PROGRAM bit is set to PROGRAM.

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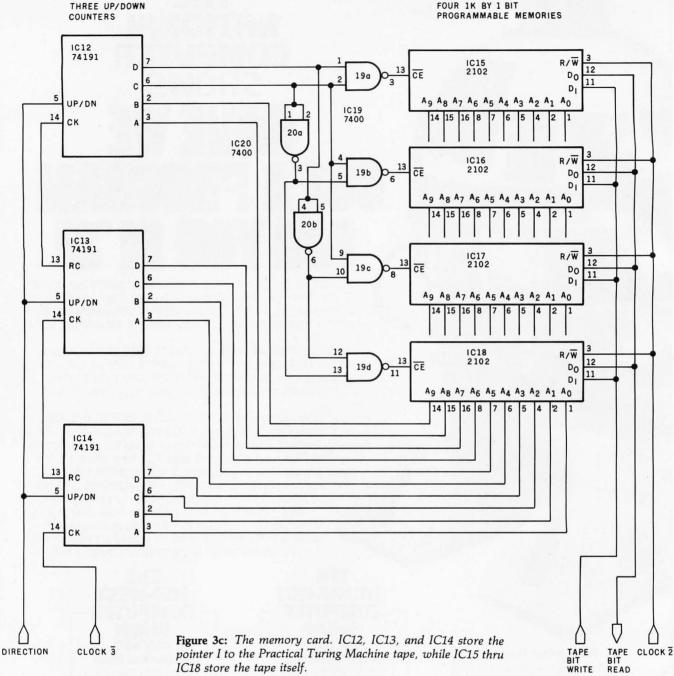
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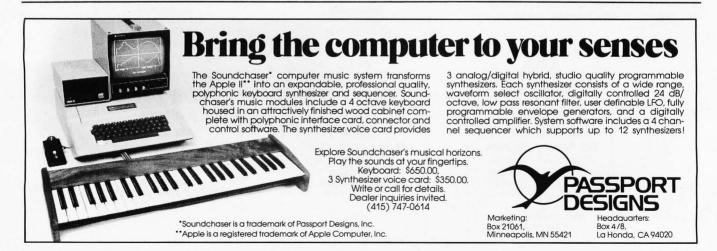
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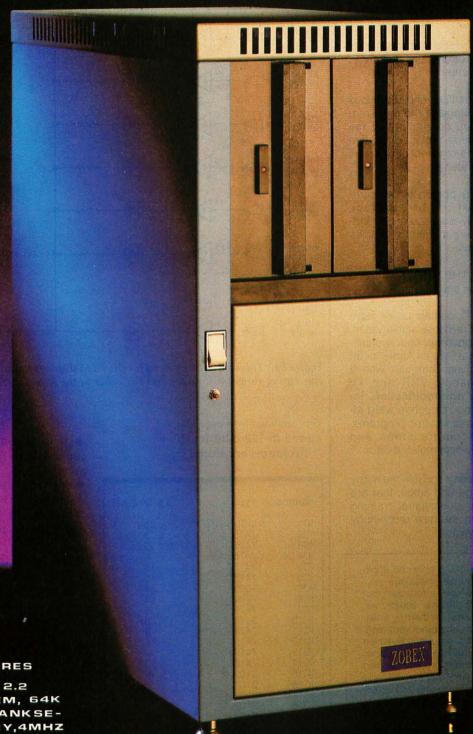
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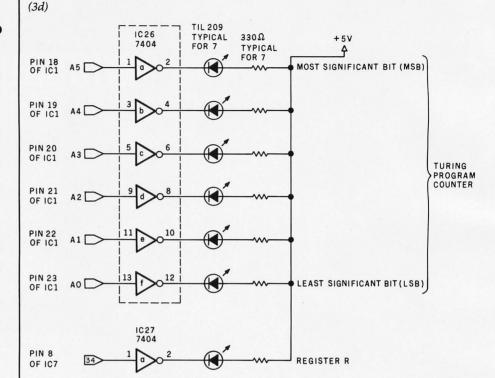


Figure 3d: This simple front panel for the PTM displays the address being pointed to by the Turing Program Counter and the value in the R register.

Text continued from page 128: stored in 128 8-bit locations. Programs are stored by:

Number	Туре	+5 V	GND
IC1 IC2 IC3 IC4 IC5 IC6 IC7 IC8 IC10 IC11 IC12 IC13 IC14 IC15 IC16 IC17 IC18 IC19 IC20 IC21 IC22 IC23 IC24 IC25 IC26 IC27	MCM6810 7475 7475 7475 74157 74157 7400 7400 7476 7476 7476 74191 74191 74191 2102 2102 2102 2102 2102 2102 2102 7400 7400 7400 7400 7400 7476 7476 7476	24 5 5 5 16 16 14 5 5 5 16 16 16 9 9 9 14 14 14 5 5 8 14 14	1 12 12 12 8 8 7 7 13 13 13 8 8 8 10 10 10 7 7 7 7 13 13 13 17 7 7

Table 1: Power-wiring table for figures 3a, 3b, and 3c.

- •single-stepping the programming counter to the desired statement number,
- selecting the proper side of the statement with the L/R switch,
- loading the values for W, D, and ADR via the programming switches, and
- depressing the "write" button.

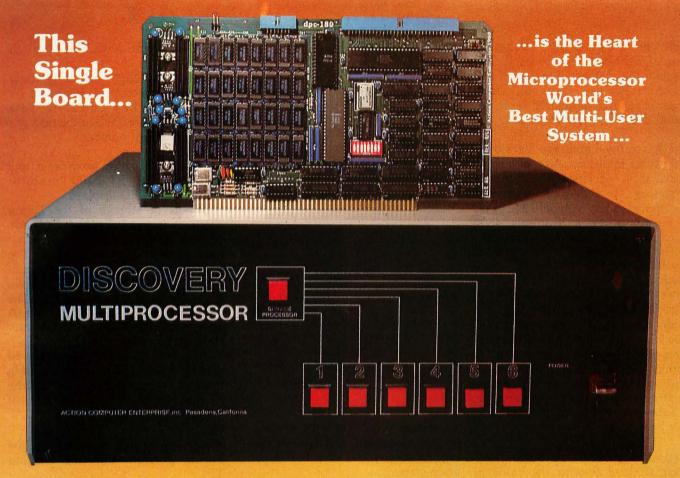
This sequence is repeated until all of the program has been entered.

Execution is initiated by:

- •single-stepping the starting location of the Turing program into register TPC, and
- switching to RUN mode.

Timing signals are provided by a 4-phase clock through the inputs labeled clock 1 thru clock 4.

This representation offers a relatively fast execution time of about 2 μ s per cycle. Changes in the length of the tape or in the maximum number of program statements are extremely difficult to make. Output is limited only by the imagination and



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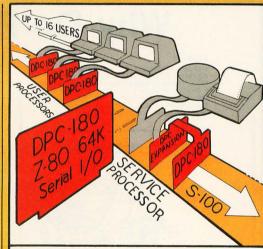
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means of the user. In my prototype, a row of light-emitting diodes (LEDs) displays the contents of register R and register TPC (see figure 5). Components for this hardwired representation of a PTM cost about \$80.

An Assembly-Language Version

Another implementation of a Practical Turing Machine is with a microprocessor. The code given in listing 1 is designed to run with only 512 bytes of memory and a Motorola 6800 microprocessor. The main program, as written, uses monitor routines available on the Heathkit ET-3400 Trainer. The tape index I is represented by the contents of locations I2 and I1. The variable I1 points to an 8-bit word in the tape array. The 3 least significant bits of the contents of the location I2 point to a bit within that word. A maximum of thirty-two program statements may be stored in 64 bytes of memory.

Subroutine RUN is divided into five parts:

•statements 0000 thru 0016 (hexadecimal) load R with the value of TAPE (I)

STM #	R = 0	R = 1
0	0080	00A0
1 2 3	0081 0082 0083	00A1 00A2 00A3
	•	
	•	•
31	009F	OOBF
		D — A D R — 6 5 4 3 2 1 0

Figure 4: Memory map of assembly-language implementation of a Practical Turing Machine. Memory locations hexadecimal 0080 thru 00BF are used to store a program of up to thirty-two steps, with 2 bytes being used to store each statement line. The character to be written, W, is in bit 7 of a given byte. The direction of tape head movement, D, is in bit 6. The statement number of the next statement to be executed is stored in bits 4 thru 0 of the byte. Bit 5 is unused.

- •statements 0017 thru 001C (hexadecimal) establish an offset for finding the proper half of a Turing program statement
- •statements 001D thru 002F (hexa-

decimal) print W(R,TPC) on the TAPE

- statements 0030 thru 0044 (hexadecimal) increment or decrement *I*
- statements 0045 thru 0049 (hexadecimal) restore TPC to the next program statement number

The main program provides output through the ET-3400 monitor routines and LED displays.

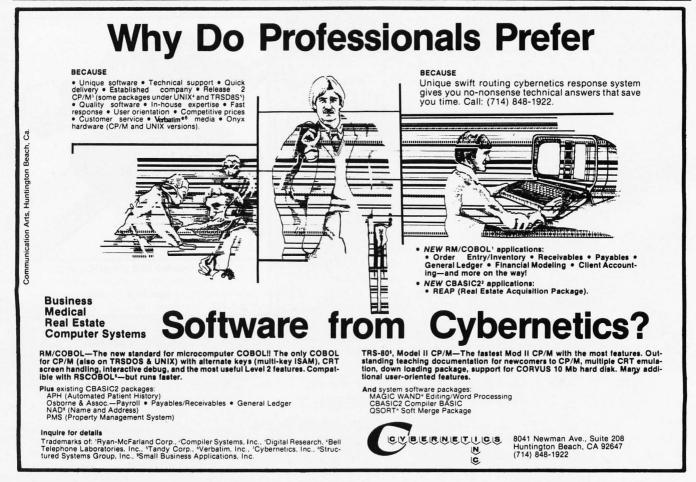
Details of storage of the Turing program appear in figure 4. Each side of each program statement is stored in a separate memory location. The value of W occupies the most significant bit and the value of D occupies the next most significant bit. The value of ADR is stored in the 5 least significant bits of a Turing program statement location.

Program statements are entered directly into memory locations using monitor routines available on the trainer.

Execution is initiated by:

• entering the starting location of the Turing program into the location TPC,

Text continued on page 146



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Listing 1: Listing for implementation of the Practical Turing Machine in 6800 machine code. The program uses routines from the Heathkit ET-3400 microprocessor trainer at hexadecimal locations 0058 and 005B.

```
MICRO-TURING
"
      PRACTICAL TURING MACHINE SIMULATOR FOR USE WITH A 6800 MPU
"
      AND AT LEAST 512 BYTES OF RAM. THE MAIN PROGRAM USES MONITOR
      ROUTINES AVAILABLE ON HEATHKIT'S MODEL ET-3400 MICROPROCESSOR
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"
                              MICRO-TURING
**
MEM.
                                          COMMENTS
LOC. OP. CODE LABEL MNEMOMIC
                                           " READ TAPE
                                           " SET UP TAPE MASK FROM (I2)
                                          A = 000000001
                      LDA A # $01
0000 86 01
               RUN
                                           B=I2
                      LDA B I2
0002 D6 4A
                      AND B # $07
                                          B=00000111 .AND. B
0004 C4 07
                                          IF (B=0) GO TO NEXT
0006 27
         04
               FIRST BEQ NEXT
                                          A=2*A
0008 48
                      ASL A
0009 5A
                      DEC B
                                           B=B-1
                                           GO TO FIRST
000A 20 FA
                      BRA FIRST
                                           R = B (= 0)
000C D7 4F
               NEXT
                      STA B R
                                           " LOAD R WITH TAPE (I2, I1)
                      LDX Il
000E DE 4B
                                           IF ((A.AND.TAPE(I1)).EQ.0) Z=1,ELSE Z=0
                      BIT A $00, X
0010 A5 00
                                           IF (Z=1) GO TO ENDR
                      BEQ ENDR
0012 27 09
0014 5C
                      INC B
                                           B=B+1
0015 D7
                      STA B R
                                           R=B(=1)
        4 F
                                           " LOAD B WITH TURING PROGRAM STM(R, TPC)
0017 D6 4E
                      LDA B TPC
                                           B=TPC
0019 CB 20
                      ADD B # $20
                                           B=B+$20
001B D7 4E
                      STA B TPC
                                           TPC=B
               ENDR
001D DE 4D
                      LDX TPC
                                           X = TPC
001F E6 80
                      LDA B $80,X
                                           B=TURING PROGRAM STM(R, TPC)
0021 DE 4B
                      LDX Il
                                           X=I1
                                           " WRITE ON TAPE
0023 C5 80
                      BIT B # $80
                                           IF((B.AND.10000000).EQ.0) Z=1,ELSE Z=0
0025 27 04
                      BEO WZERO
                                           IF (Z=1) GO TO WZERO
0027 AA 00
                      ORA A $00, X
                                           A=A.OR.TAPE(I1)
0029 20 03
                      BRA ENDW
                                          GO TO ENDW
002B 43
               WZERO COM A
                                           A=.NOT.A
002C A4 00
                      AND A $00,X
                                           A=A.AND.TAPE(I1)
002E A7 00
               ENDW
                      STA A $00,X
                                           TAPE(II) = A
                                           " MOVE TAPE POINTER
0030 CE 00 4A
                      LDX # $004A
                                           X=$004A
0033 C5 40
                      BIT B # $40
                                           IF((B.AND.01000000).EQ.0) Z=1,ELSE Z=0
0035 27 08
                      BEQ DEC1
                                           IF (Z=1) GO TO DEC1
                                           " INCREMENT (I2, I1)
0037 6C 02
                      INC $02, X
                                           I1 = I1 + 1
0039 28 UA
                      BVC ENDD
                                           IF(I1.NE.-128) GO TO ENDR
003B 6C 00
                      INC $00, X
                                           12=12+1
003D 20 06
                      BRA ENDD
                                           GO TO ENDD
                                           " DECREMENT (12,11)
003F 6A 02
               DEC1
                      DEC $02,X
                                           I1=I1-1
0041 28 02
                      BVC ENDD
                                           IF(I1.NE.127) GO TO ENDD
0043 6A 00
                      DEC $00, X
                                           I2=I2-1
                                           " TPC=ADR(R,TPC)
0045 C4 1F
               ENDD
                      AND B # $1F
                                           B=B.AND.00011111
0047 E7 04
                      STA B $04, X
                                           TPC=B
0049 39
                      RTS
                                           RETURN
                                           " VARIABLES
004A XX
               12
                      (I2)
                                           I 2
004B 01
                      $01
004C XX
               11
                      (I1)
                                           Il
004D 00
                      $00
                                                                      Listing 1 continued on page 142
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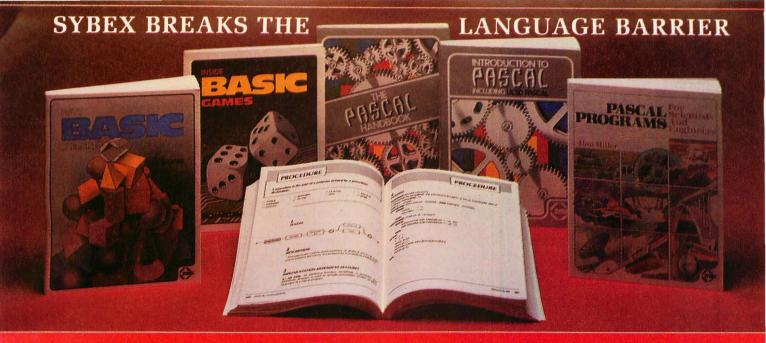
Listing 1 continued:

004E XX	TPC ((TPC)	TPC
004F XX	R ((R)	R
			" MAIN
0054 8D AA 0056 96 4F 0058 BD FC BC 005B BD FE 3C 005E 01 01 01 0061 20 F0	I S P	BSR RUN LDA A # R JSR REDIS JSR OUTHEX NOP BRA MAIN	BRANCH TO SUBROUTINE RUN A=R "SET UP DISPLAY ADDRESS "DISPLAY CONTENTS OF A "SPACE FOR ANOTHER JSR GO TO MAIN
			" END MAIN
0080 00 0081 81 00A0 81 00A1 00	(0,0) (0,1) (1,0) (1,1)		" LOCATIONS \$0080 THRU \$00BF " RESERVED FOR TURING PROGRAM " STATEMENTS " (1,0) = (R,TPC)
0100 XX THRU XX 01FF XX			" TAPE " TAPE " TAPE
			" XX= LOCATION FILLED JUST PRIOR TO

Listing 2: Listing for implementation of the Practical Turing Machine in FORTRAN.

```
100 "
                                            TURING
110 "
             UNIVERSAL TURING MACHINE SIMULATOR, JIM WILLIS , PHYSICS DEPARTMENT
120 "
             UNIVERSITY OF NORTH CAROLINA , CHAPEL HILL NORTH CAROLINA.
130 "
             DESIGNED TO RUN ON UNCCC'S VERSION OF IBM'S 360/370 CALL-OS
140 "
                                            TURING
150
          DIMENSION ITAPE(128)
160
          INTEGER *2 W(2,64),D(2,64),ADR(2,64),TAPE(128),TPC,WI,DI,ADRI,T
          DATA YZ'Y'Z
170
180 1000
                WRITE(3,100)
190
     100
                FORMAT( ' HOW MANY SPACES IN THE TAPE? 128 MAX. ')
200
                READ(1,*) MTAPE
210
          IF(MTAPE.GT.128) MTAPE=128
220 1001
                WRITE(3,102)
230
     102
                FORMAT(' INPUT TURING PROGRAM.WO.DO.ADRO.WI.DI.ADRI.WO=2 TO END')
240
          NSTM=0
250
      1.
              NDEX≔NSTM+1
260
          WRITE (3,103)NSTM
270
     103
                FORMAT( STM.NO.
                                  (yI2)
280
          READ(1,*)W(1,NDEX),D(1,NDEX),ADR(1,NDEX),W(2,NDEX),D(2,NDEX),ADR(2,NDEX)
290
          IF(NSTM.EQ.64)GOTO 2
300
          IF(W(1,NDEX),GT,1)GOTO 2
310
          NSTM=NSTM+1
320
          GOTO 1
      2
330
               WRITE(3,104)
340
                FORMAT(
                          NO. WO
     104
                                  00
                                        ADRO
                                             Wil.
                                                  11.1
                                                       ADRI/)
          DO 3 I=1,NSTM
350
360
          N=1-1
370
          WRITE(3,105)N,W(1,I),D(1,I),ADR(1,I),W(2,I),D(2,I),ADR(2,I)
380
     105
                          (y414y/\('y314)
                FORMAT( /
390
       3
                CONTINUE
400
          WRITE (3,106)
410
     106
                FORMAT( 'INPUT FIRST TURING PROGRAM STM. NO. ')
420
          READ(19*)TPC
                                                                     Listing 2 continued on page 144
```

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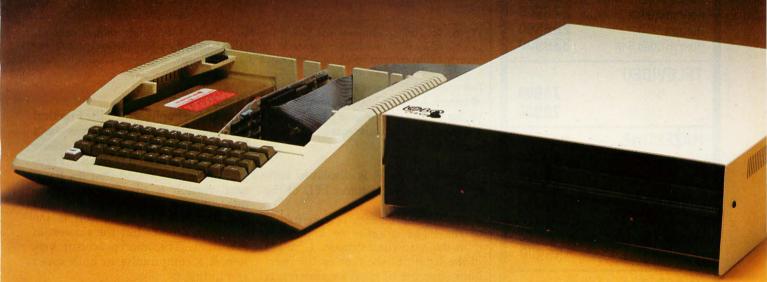
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Listing 2 continued:

```
430
           WRITE(3,107)
                FORMAT( ' HOW MANY TIMES THROUGH THE TAPE? ')
440
     1.07
450
           READ(1,*)MIT
           WRITE(3,119)
460
470
                FORMAT( / INPUT CHARACTER FOR ZERO, /)
     119
480
           READ(1,120)IZERO
490
     120
                FORMAT(A1)
500
           WRITE(3,121)
                FORMAT( / INPUT CHARACTER FOR ONE, /)
510
     121
520
           READ(1,120)IONE
530
540
           INITIALIZE TAPE TO ZERO
550
           DO 4 T=1,MTAPE
560
570
           TAPE(I)=0
580
                CONTINUE
590
           KIT=0
600
610
           TAPE LIST ROUTINE
620
630
           KTAPE=1
640
       9
                KIT=KIT+1
650
           DO 32 N=1,MTAPE
660
           ITAPE(N)=IZERO
670
           IF(TAPE(N).EQ.O)GOTO 32
680
           ITAPE(N)=IONE
690
      32
                CONTINUE
700
710
720
230
           WRITE(3,118)(ITAPE(I),I=1,MTAPE)
740
750
     118
                FORMAT(128A1)
760
           IF(KIT.EQ.MIT)GOTO 99
770
780 "
            RUN
790
800
     200
                CONTINUE
810
           TPC=TPC+1
820
           T=TAPE(KTAPE)+1
830
           DI=D(T,TPC)
840
           TAPE(KTAPE)=W(T,TPC)
850
           IF(DI.EQ.1)GOTO 201
860
           KTAPE=KTAPE-1
870
           IF(KTAPE.LT.1)KTAPE=MTAPE
880
           GOTO 202
890
     201
                KTAPE=KTAPE+1
900
           IF(KTAPE.GT.MTAPE)KTAPE=1
910
     202
                TPC=ADR(TyTPC)
920
             IF(KTAPE.EQ.MTAPE)GOTO 9
930
           GOTO 200
940
      99
                WRITE(3,108)
950
                FORMAT( ' WANT TO CHANGE THE TAPE LENGTH?')
     108
960
           READ(1,109)ANSWER
970
           IF (ANSWER, EQ, Y) GOTO 1000
     109
980
                FORMAT(A1)
990
           WRITE(3,110)
      110
                 FORMAT( / WANT TO REPROGRAM? /)
1000
1010
            READ(1,109)ANSWER
1020
            IF (ANSWER.EQ.Y)GOTO 1001
1030
           GOTO 2
1040
           END
```

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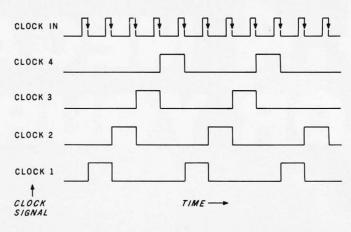


Figure 5: Timing diagram for the four-phase clock. The signals shown here are generated by IC23 and IC24 in figure 3a. Note that within the schematic of figure 3c, the inverted counterparts of clock 2 and clock 3 are also used.

Text continued from page 138:

• entering the DO-0054 command into the trainer (this begins program execution at hexadecimal location 0054).

The value of R is displayed continuously on the leftmost LED of the

The microprocessor representation of the PTM is easier to implement than the hardwired version. Changes in the length of the tape or the maximum number of program statements are relatively easy to make, but the microprocessor is very slow compared with the hardwired version. Subroutine RUN requires about 150 us per cycle as compared with 2 µs for the hardwired version.

A FORTRAN Version

One of the most useful and comprehendable representations of a PTM is one written as a high-level language program. Listing 2 is a source listing for an interactive FOR-TRAN program that can be used to simulate a PTM. The run section of this program follows the flowchart in figure 2.

The program is stored in three arrays dimensioned W(2,64), D(2,64), and ADR(2,64). The maximum length of the tape is 128 characters. A shift is made in the subscripts to allow R=0 and TPC=0. Output characters for the tape are chosen by the user rather than being restricted to 0 and 1. Program statements are entered as six-component vectors and can be readily changed. The most important variables are available interactively to the user.

Summary

We have implemented the Practical Turing Machine in three forms—as a hardwired circuit, a 6800 machine code program, and a FORTRAN program. We have found that the hardwire version is the fastest but the most difficult to run or modify, and that the FORTRAN version is the easiest to modify but the slowest in execution. The microprocessor version is a compromise in both speed and utility. ■

Acknowledgments

I would like to thank Tom Ainsworth for his help in the design of the hardwired version, Dr W J Thompson for his guidance during the project, and Alice Glenn for her help in the preparation of the manuscript. The research for this article was supported in part by the United States Department of Energy.

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System Notes

A Relocatable Bootstrap for the Tarbell Disk Controller

Hector M Smith 9852 Dandelion Ave Fountain Valley CA 92708

Some Z80 microprocessors do not work properly with the Tarbell disk-controller ROM (read-only memory). For example, Ithaca Intersystems recommends that the bootstrap program be relocated to high memory and that a power-on jump to it should be executed. You can make the program independent of memory location by using the Z80 relative-jump instruction.

Listing 1 is a relocatable version of the Tarbell bootstrap loader. Relative jumps are included at hexadecimal locations 0010 and 0016. A test bit instruction is located at hexadecimal 000E.

The original 8080 code is shown in listing 2. In the

code, at hexadecimal locations 000E and 000F, ORA resets the sign flag if the MSB (most significant bit) of INTRQ is 0. If this is the case, JP jumps to RDONE.

Because the Z80 does not have a relative jump instruction activated by a positive test, BIT 7,A is used to check if bit 7 (INTRQ) is 0. If it is, a jump relative to RDONE is executed. At hexadecimal location 0016, a jump relative to RLOOP and NOP was substituted for the original jump.

The modified bootstrap (listing 1) can be located anywhere in memory. A jump to it will boot the CP/M operating system. ■

Listing 1: A Z80 relocatable bootstrap program for the Tarbell disk controller. The mnemonics are TDL Assembler.

ADDR MACH CODE	LABEL	ASY	LANGUAGE	COMMENTS
	роот	TNI	747 X TO	WATE FOR HOME
0000 DB FC 0002 AF	BOOT:	IN XRA		;WAIT FOR HOME.
0002 AF 0003 6F		MOV	A L,A	;COMPLETE. ;SET L=0.
0003 67		MOV		;H&L=0.
0004 07 0005 3C		INR		;SET A = 1.
0006 D3 FA		OUT		;SECTOR = 1.
0008 3E 8C		MVI		;READ SECTOR.
000A D3 F8		OUT		,
000C D2 FC	RLOOP:	IN	WAIT	;WAIT FOR DRQ OR INTRQ.
000E CB 7F		BIT		;TEST BIT 7
0010 28 07		JRZ		;DONE IF INTRQ
0012 DB FB		IN		;READ A BYTE OF DATA.
0014 77		MOV	A CONTRACTOR OF THE PARTY OF TH	;PUT INTO MEMORY.
0015 23		INX		;INCREMENT POINTER
0016 18 F4		JMPR	RLOOP	;DO IT AGAIN
0018 00 0019 DB F8	DDONE	NOP	DOTAT	;FILLS EMPTY SPACE
0019 DB F8	RDONE:	IN ORA	A	;READ DISK STATUS. ;SET FLAGS.
001C CA 7D 00		JZ		;IF ZERO, GO TO SBOOT.
001C CA 1D 00		HLT	07D11	;DISK ERROR, SO HALT.
0011 10	WAIT		OFCH	,DISK EIIIOII, SO IIAEI.
	SECT		OFAH	
	DCOM		OF8H	
	DDATA	=	OFHB	
	DSTAT	=	OF8H	

Listing 2: Original 8080 code before modification for the Z80 microprocessor.

000E	B7	ORA	A
000F	F2 19 00	JP	RDONE
0016	C3 0C 00	JMP	RLOOP

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A Closer Look at the TI Speak & Spell

Peter Vernon 31 Georgina St Newtown NSW 2042 Australia

Congratulations to Michael Rigsby on his article "Dissecting the TI Speak & Spell" (September 1980 BYTE, page 76). He is not alone in desiring an economical voice-output device for his computer, and the Speak & Spell is an excellent choice. Economy is one reason, and the circuitry of this device has features that make it potentially one of the most flexible and comprehensive speech synthesizers available.

The problem is how to interface the Speak & Spell to a computer. Mr Rigsby's approach is the first step, but it allows only a spelling computer, not a talking one. In order to achieve more, it is necessary to know something about the workings of the device. This information is difficult to obtain. Texas Instruments has not been very informative, although considering the investment it has in speech technology this is perhaps understandable. Thus, the Speak & Spell is an irresistible challenge to the experimenter.

Mr. Rigsby has, however, made one fundamentally incorrect assumption: the TI Speak & Spell is most definitely *not* based on the SN76477N complex-sound generator, nor does it store words, or even phrases, as individual pulses in memory. As I will show, it uses an entirely different technique.

The Heart of the Unit

The TMC0281NL is a proprietary Texas Instruments integrated circuit that is virtually an entire digital signal processor, with timing and decoding circuits, a 10-pole digital lattice filter, and a D/A (digital-to-analog) con-

verter. All of this is contained on a tiny piece of silicon just 44 mils square. This is the heart of the speech synthesizer.

Also on the board is the controller, the TMC0271NL, which is a member of the TMS-1000 microprocessor family. The TMC0271 shares the same basic architecture as the TMS-1000 used in TI's calculators, but it has been modified to enhance its BCD (binary-coded decimal) arithmetic capabilities. It also has an expanded instruction set and an output multiplexer to reduce the number of pinouts required in its role as a controller for the speech synthesizer IC (integrated circuit).

The Speak & Spell is an irresistible challenge to the experimenter.

As Mr Rigsby guessed, the other two integrated circuits on the board are high-density ROMs (read-only memories). The TMC0350 family are 128 K-bit ROMs, organized as 16 K by 8 bits. They incorporate an internal 18-bit address counter/register and two 8-bit output buffers, with the four high-order bits of the address driving a 1-of-16 device-select decoder and the other 14 bits addressing the ROM array directly.

Linear Predictive Coding

The circuitry is only part of the story. The real secret of the Speak & Spell and other Texas Instruments speech-synthesis devices is a tech-

nique called LPC (linear predictive coding). This technique makes it possible to encode a complex speech waveform with relatively little data. A speech signal is highly redundant, made up of a few basic waveforms that are repeated to produce speech sounds. Essentially, LPC eliminates the redundancy inherent in the speech signal and retains only the data required to drive the speech synthesizer.

The TMC0281 can be thought of as an electronic model of the human vocal tract. The data input is a description of the filter parameters necessary to model the vocal tract as its characteristics change over time. Codes for twelve synthesis parameters are stored in the ROMs. These parameters are ten filter coefficients, and pitch and energy information.

The filter parameters are derived from samples of actual speech and are encoded by a complex mathematical algorithm that makes it possible to predict a speech waveform based on information derived from previous waveforms. Because of the finite-time response of the human vocal tract, only a fixed number of speech sounds can follow a particular vocalization.

To produce speech, the controller specifies the starting point of a string of data stored in the ROMs. The ROM output provides the pitch, amplitude, and filter parameters from which the synthesizer constructs the speech waveform.

The input to the filter is either a periodic or random sequence of pulses. A random sequence of pulses is used to recreate unvoiced sounds,

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such as "f" or "s," while a periodic sequence creates voiced sounds such as "a." The pitch information either varies the frequency of the periodic pulses or, if all the bits are zero, selects random noise as the input to the lattice filter. An amplification factor is also input to the synthesizer and adjusts the amplitude of the excitation source to produce sounds of varying intensity.

The lattice filter of the synthesizer has ten stages. Each stage carries out two multiplications and two additions on its two digital inputs before passing the results backward and forward to its neighbors. The operations of the ten stages are carried out sequentially, as are the operations within each stage. Through careful consideration of timing and the use of a pipeline approach, only one adder and one multiplier are needed to carry out the mathematical operations. Each separate arithmetic operation requires only 6 μ s.

Figure 1 is a block diagram of the basic elements of the TMC0281. The multistage lattice filter uses the parameters K1 thru Kn to digitally filter the amplified excitation signal, and passes its output to a D/A converter connected to the speaker.

The coefficients of the filter are updated approximately every 20 ms. However, because of the redundancies in speech patterns, a complete set of parameters is not always required. Sections of the data stream may be replaced by a single "repeat" bit, cutting the data required to control the filter from a maximum of 49 bits to a minimum of 4, thus conserving memory space.

During speech the TMC0281 accesses the ROMs directly until it receives an end-of-phrase command and returns control to the TMC0271 controller. Five lines are used to transfer data and commands within the system. One of these lines is the processor data clock, which determines when the data on the other four lines is valid. These are the five lines mentioned by Mr Rigsby.

Timing

Timing for the synthesizer is based on a 50 Hz frame rate-so a new speech segment is read from the ROM every 20 ms. The speech patterns coded in the ROM are sampled at a rate of 10 kHz, which corresponds to the maximum bandwidth of speech-5

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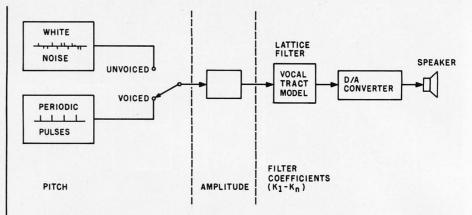


Figure 1: Block diagram of the heart of the TI Speak & Spell—the Texas Instruments TMC0281NL integrated circuit. The TMC0281NL is a proprietary circuit that is virtually an entire digital signal processor and can be thought of as an electronic model of the human vocal tract. It includes timing and decoding circuits, a 10-pole digital lattice filter, and a D/A converter. Speech synthesis takes place through a process called LPC (linear predictive coding), which makes it possible to encode a complex waveform with relatively little data. Either pseudo-random noise (for unvoiced sounds) or periodic pulses (for voiced sounds) are amplified and fed to the lattice filter, which models the vocal tract in accordance with coefficients stored in two external 16 K by 8-bit ROMs (read-only memories). A maximum of 49 bits is needed to specify each sound pattern, which is updated every 20 ms. This results in an overall data rate of 2400 bps (bits per second). The TMC0281NL is controlled by a TI TMC0271 microprocessor, a specialized member of the TMS-1000 microprocessor family.

kHz. (The maximum bandwidth for telephone-quality speech is 3.5 to 4.5 kHz.) An 800 kHz oscillator is divided by four to produce the major system clock. This four-phase clock controls the transfer of data within the system. The individual bit patterns in each 20 ms frame are clocked into the synthesizer at a rate corresponding to the sample frequency of 10 kHz. It is this clock which produces the 0.1 ms pulses measured by Mr Rigsby.

A maximum of 49 bits is needed to specify the sound pattern that will be produced every 20 ms. This is an overall data rate of about 2400 bps (bits per second). One hundred seconds of speech time thus requires the storage of 240,000 bits of information, which corresponds well with the 256,000 bits of storage provided by the two TMC0351 ROMs.

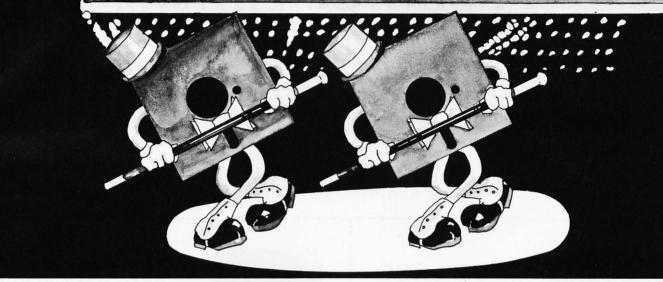
Capabilities and Challenge

Because the Speak & Spell reconstructs speech sounds from a constant-excitation signal filtered under digital control, it is potentially capable of reproducing any sound at all. The challenge for the experimenter is to determine what information needs to be input to create a particular sound. Trial and error seems to be the only approach. With

much work it would be possible to determine which combinations of data are needed to produce each phoneme of the English language. (All words are made up of combinations of particular sound units called *phonemes*. About 42 phonemes are used in the English language.) These phoneme patterns could be stored in memory and arranged to produce any word. At 49 bits per phoneme and 42 phonemes, only 2058 bits are required. The problem is, of course, to find the right bits.

Perhaps the best place to start would be the connector provided for the attachment of expansion modules. The module-select key on the keyboard of the Speak & Spell is used to signal the controller that an expansion module is in place and that it should instruct the synthesizer to access this module rather than the ROMs on the main circuit board. By using this signal it is possible to force the synthesizer to accept data that is input on the module connector. The system clock can be used to govern the rate of this data input. Experimenting with this approach produces a weird and wonderful series of sounds. At present, my computer (an Exidy Sorcerer) can only grunt and squeak, but after all, that's how we all started!■

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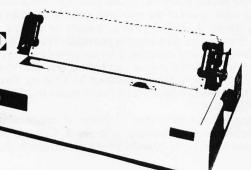
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- 5. Application of computers in medical practices.
- 1. The Pocket Computer Newsletter
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- 5. User Groups: S-100, TRS-80, and 6502.
- 1. Digiac Corporation
- 2. 175 Engineers Rd, Smithtown NY 11787
- 3. James D Gobetz, President, (516) 273-8600
- 4. MAPS Digest
- 5. For MP/M users.
- 1. CAMS (Capital Area Micro Computer Society)
- 2. POB 348, Ridge Rd, RD #1, Scotia NY 12302
- 3. Stanley L Mathes, (518) 372-3767
- 4. Occasional

- 5. Subgroups for Apple (associated with International Apple Corps), TRS-80, S-100, and other groups.
- 1. Sphere Microcomputer Group
- 2. 2 Tor Rd, Wappingers Falls NY 12590
- 3. Jeffrey Brownstein, DDS, (914) 297-3950
- 4. Sphere Newsletter
- 5. 6800 microcomputers.
- 1. CHIP-S Microcomputer Club
- 2. POB 504, Syracuse NY 13201
- 1. Mohawk Valley Microcomputer Club
- 2. 706 Lee St, Rome NY 13440
- 3. Rich Weaver
- 4. Micros Along the Mohawk
- 5. Several special interest groups: 6800, 8080/Z80, and beginners.
- 1. RAMS (Rochester Area Microcomputer Society)
- 2. POB 90808, Rochester NY 14609
- 3. Erwin Rahn, (716) 473-3184
- 4. Memory Pages
- 5. Special interest groups: UFORTH (University of Rochester FORTH) and 6800/6809/68000. Users groups: North Star and CP/M.
- 1. Monroeville Apple Users Club
- 2. Dr G J Harloff
- 3. 579 Carnival Dr, Pittsburgh PA 15239
- 1. Central Pennsylvania Computer Club
- 2. 3263 Bull Rd, York PA 17404
- 3. Cletus Hunt III, (717) 764-4977
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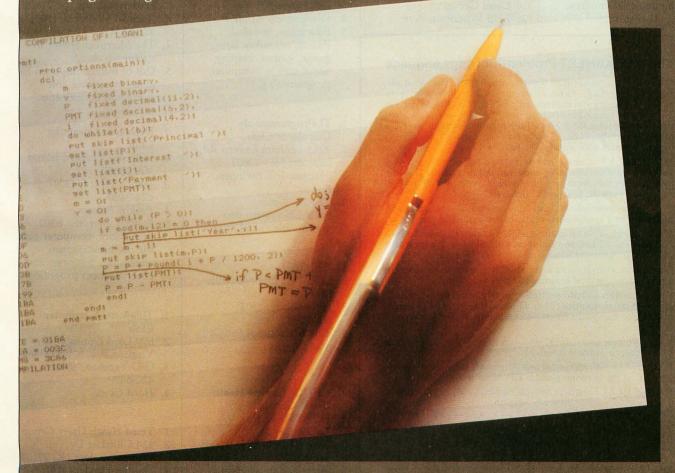
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- 3. Art Prutzman, (717) 287-1014
- 5. Special interests: TRS-80 uses and modems.
- Delaware Valley Computer Society
- 2. POB 651, Levittown PA 19058
- 3. Howard Kalodner, (215) 742-6612
- 4. DVCS Newsletter
- 5. TRS-80 users group.
- 1. PACS (Philadelphia Area Computer Society)
- 2. POB 1954, Philadelphia PA 19105
- 3. Dick Moberg, Eric Hafler; Hot line (215) 925-5264
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- Users groups for all major microcomputers, courses on languages, computers for children, and other groups.

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- 2. 325-B Pennsylvania Ave SE, Washington DC 20003
- 3. Charles Floto, (202) 544-0484
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- Eric Balkan, (301) 770-2726
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- 1. TI Programmable Calculator Club
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- Maurice E T Swinnen, Editor
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- 5. All AOS system programmable calculators.
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- 3. Al Peabody, (301) 268-0561
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PROFESSIONAL TIME ACCOUNTING: PTA Asyst Design PTA Demo Asyst Design ESQ-1 Legal Micro Information ESQ-1 Legal Demo Micro Information DATEBOOK™ Organic Software	595 75 1495 75 295	40 40 50 50 25	A,C,I A,C,I A,C,I,L A,C,I A,I
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PLANNING & ANALYSIS: MINIMODEL Financial Planning STATPAK NW Analytical MILESTONE™ Organic Software	495 500 295	50 40 25	A,C,I,L A,D,I A,I
TELECOMMUNICATIONS: ASCOM DMA	125	10	А,Т
DATA MANAGEMENT: CBS DMA CBS LABEL OPTION DMA MAGSAM III MAG MAGSAM IV MAG SELECTOR IV Micro-Ap PRISM/IMS MAG PRISM/ADS MAG	395 80 145 295 395 495 795	40 10 25 25 25 25 55 55	A,F,K A,F,K A,C or D,F A,C,F,K A,C,F,K A,C,F,K A,C,F,K
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- (E) BASIC-80 version 5.0 or higher.
- (F) 48K memory or greater. (G) 56K memory or greater.
- (H) 64K memory

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- (K) Cursor addressable termina
- (L) signed license required for shipment. (O) specify 8080, Z80, or CDOS.
- (P) give CP/M serial number.
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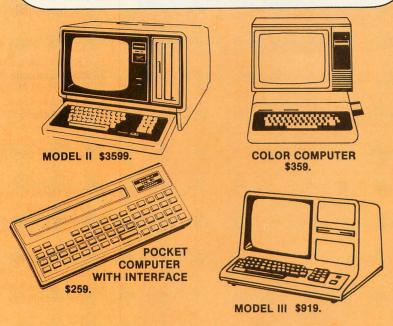
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- 2. POB 31424, Raleigh NC 27612
- 3. Joseph H Budge, (919) 489-4284
- 4. From The Core
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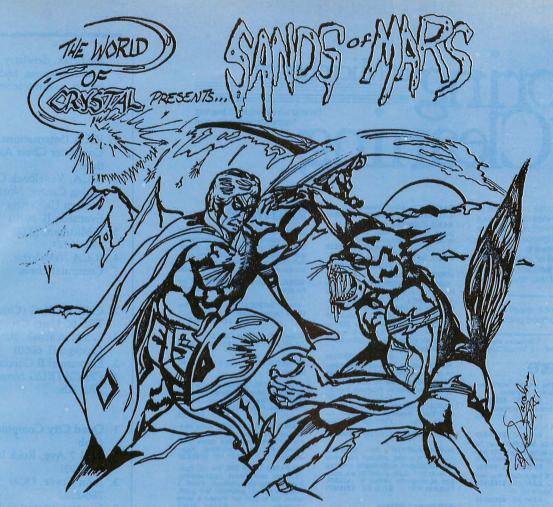


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medicine, dentistry, health sciences, and micro- and minicom-

- 1. ICCA (International Computer Chess Association)
- 2. ICCA, Vogelback Computing Center, Northwestern University. Evanston IL 60201
- 3. B Mittman, (312) 492-3682
- 4. ICCA Newsletter
- 5. Computer chess.
- 1. CHICATRUG (Chicago TRS-80 Users Group)
- 2. 203 N Wabash, Rm 1510, Chicago IL 60601
- 3. Emmanuel B Garcia Ir
- 4. CHICATRUG News
- 5. TRS-80s.
- 1. Quad City Computer Club
- 2. 4211 7 Ave, Rock Island IL 61201
- 3. John Greve, (309) 786-8187
- 5. General-interest club.
- 1. SCAMPUS (SC/MP Users Society)
- 2. POB 132. Knob Noster MO 65305
- 3. Tom Bohon, Coordinator, (816) 563-2650
- 4. SCAMPUS Newsletter
- 5. Anything to do with National Semiconductor's SC/MP I and II integrated circuits (systems, controllers, etc).
- 1. Financial Systems Report
- 2. c/o Syntax Corporation, 4500 W 72nd Ter, Prairie Village KS 66208
- 3. Vernon K Jacobs, (913) 362-9667
- 4. Financial Systems Report
- 5. This 8-page monthly newsletter provides information about computer systems for financiers.
- 1. Lincoln Micro-Computer Club
- 1209 Garber Ave, Lincoln NE 68521
- 3. Hubert Paulson Jr, (402) 435-1507

Clubs and Newsletters.

- 2. POB 1131, Troy MI 48099
- 3. Don Gottwald, (313) 792-3867
- 4. Sorcerer's Apprentice
- 5. This club is interested in any topics concerning the Exidy Sorcerer microcomputer.
- 1. OSI-MUG (OSI Michigan Users Group)
- 2. 3247 Lakewood Ave. Ann Arbor MI 48103
- 3. (313) 761-5358
- 1. SEMCO (South Eastern Michigan Computer Organization)
- 2. POB 02426, Detroit MI 48202
- 3. Information number, (313) 775-5320
- 4. Data Bus
- 5. Special interests: networking, TRS-80, Atari, 6800, 650X, Heath, Digital Group, CP/M, S-100, and any aspect of computing.
- 1. Detroit Interact Group
- 2. 15356 Prevost, Detroit MI 48227
- 3. Stephen Cook, (313) 272-7594
- 4. Interaction Newsletter
- 5. Special interests: the Interact computer.
- 1. Flint 6500 Users Group
- 2. POB 4310, Flint MI 48504
- 3. R Riley, (313) 695-1117, 7-8 PM weekdays
- 1. ERCC (Educational, Recreational Computer Club)
- 2. POB 325, Owasso MI 48867
- 3. John Horvath, (517) 725-2835
- 4. ERCC Newsletter
- 5. Emphasis on educational, recreational, business, and scientific uses of computers.
- 1. Battle Creek Area Microcomputer Club
- 2. 8587 Q Dr N, Battle Creek MI 49017

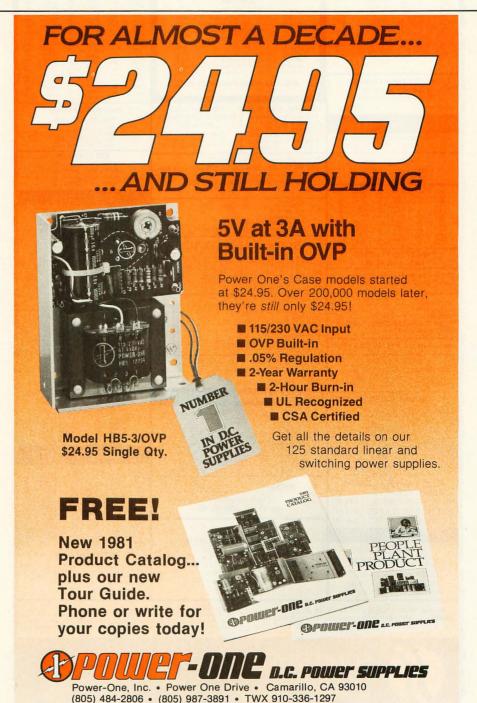
- 3. Jeff Stanton, (616) 763-9685, evenings
- 4. Yes
- 5. Special interests: mostly the TRS-80.
- 1. Heath User's Group
- 2. Hilltop Rd, St Joseph MI 49085
- 3. Bob Ellerton, (616) 982-3463
- 4. REMark
- 5. Heath hardware and software.

- 1. Microcomputer Users International
- 2. c/o Jack Decker, 1804 W 18th St, Lot #155, Sault Ste Marie MI 49783
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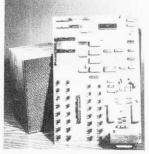
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470pt	.07	.06	.04
.001mf	07	.06	.04
.0022mf	.07	.06	.04
.0033mf	.07	.06	.04
.0047mf	.07	.06	.04
.01mf	07	.06	.04
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Part#	1+	25 +	100 +
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S14LT	18	16	14
S16LT	.21	18	16
S18LT	26	.22	18
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WIRE-W	RAP SC	LDER	TIN
Part#	1+	25 +	100 +
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S8WT	37	33	30
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Part#	1+	25 +	100 +
S8WG	.54	49	44
		.69	.62
S16WG	.83	.75	
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	DIPPI APACI			
Value	Volts			
1mf .15mf	35v 35v	.35	.30	.26 .26

.22m1	25v	.35	.30	.26
.33mf	35v	.35	.30	.26
.47mf	35v	.35	.30	.26
.68mf	35v	35	.30	.26
1mf	35v	.35	.30	.26
1.5mf	35v	45	.39	.33
2.2mf	35v	.45	.39	.33
3.3mf	35v	.50	.42	.36
4.7mf	25v	.50	.42	.36
4.7mf	35v	.65	.56	.44
6.8mf	35v	.65	.56	.44
10mf	25v	.85	.72	.61
10mf	35v	1.19	1.00	.84
15mf	25v	1.30	1.09	.92
22mf	25v	1.30	1.09	.92
33mf	25v	1.35	1.12	.95
47mf	25v	1.55	1.29	1.05
100mf	6v	2.95	2.48	2.08

4	wT				CA			FILI
		0	% I	4E	212	O	45	
0	100)	1K		10K		100K	1 M

11	110	1.1K	11K	110K	1.1M	
12	120	1.2K	12K	120K	1.2M	
13	130	1.3K	13K	130K	1.3M	
15	150	1.5K	15K	150K	1.5M	
16	160	1.6K	16K	160K	1.6M	
18	180	1.8K	18K	180K	1.8M	
20	200	2K	20K	200K	2M	
22	220	2.2K	22K	220K	2.2M	
24	240	2.4K	24K	240K	2.4M	
27	270	2.7K	27K	270K	2.7M	
30	300	3K	30K	300K	3M	
33	330	3.3K	33K	330K	3.3M	
36	360	3.6K	36K	360K	3.6M	
39	390	3.9K	39K	390K	3.9M	
43	430	4.3K	43K	430K	4.3M	
47	470	4.7K	47K	470K	4.7M	
51	510	5.1K	51K	510K	5.1M	
56	560	5.6K	56K	560K	5.6M	
62	620	6.2K	62K	620K		
68	680	6.8K	68K	680K		
75	750	7.5K	75K	750K		
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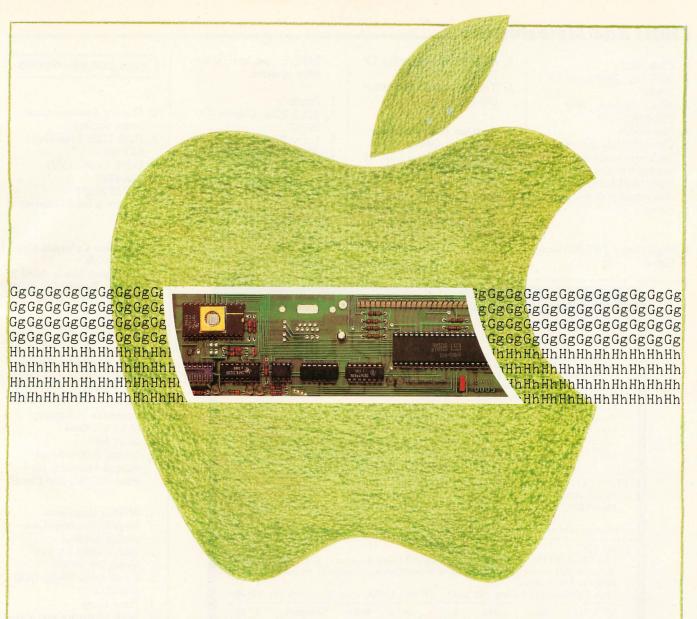
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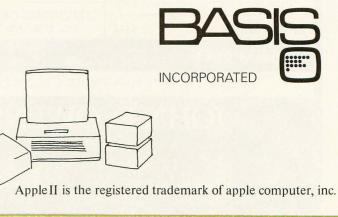
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- 4. Newsletter
- Our activities are for beginners in microcomputing. We use ELFs and other 1802-based boards that employ simple controls.
- 1. High Plains TRS-80 Users Group

- POB 30545, Amarillo TX 79120
- 3. Tom Whittenburg, (806) 374-9711
- Permian Basin Amateur Computer Group
- c/o Ector School District, POB 3912, Odessa TX 79760
- 3. John Rabenaldt, (915) 697-4607 (after 6 PM) or (915) 332-9151 (9 AM to 5 PM)
- Special interests: Selectric interfaces, color displays,

- MECA tape, and Altair 8800 systems.
- Apple π
- 2. 415 E 43rd, Odessa TX 79762
- 3. Larry Brown
- 5. Apple II microcomputers.
- Permian Basin TRS-80 Users Group
- 2. Rt #4, POB 1455, Odessa TX 79763
- 3. Allan D Emert, (915) 381-3138
- 5. TRS-80 Model I.

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- Denver Amateur Computer Society
- 2. POB 1235, Englewood CO 80150
- 3. Larry Costa, (303) 428-2929
- 4. INTERRUPT
- 5. We are a broad-interest club.
- Southern Colorado Computer Club
- Computer Shack, 1635 S Prairie, Pueblo CO 81005
- 3. Tom Thomas, (303) 564-3545
- 4. Monthly newsletter

1. Utah Computer Association

- 2. 378 E 9800 S, Sandy UT 84070
- 3. Lawrence N Barney, (801) 571-9661
- 4. UCA Bits
- Special interests: advanced software, hardware, CP/M, and Pascal.

SNPCS (Southern Nevada Personal-Computing Society)

- 2. 1405 Lucilee St, Las Vegas NV 89101
- 3. Cy or Edna Wells, (702) 642-0212
- 4. Hard Copy
- Both hardware and software; exchange of information and experience; and guidance and encouragement for new hobbyists. We participate in fairs and exhibitions.

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- Poly 88/8813 Users Group
- 13022 Psomas Way, Los Angeles CA 90009
- 3. Pat or Roger Lewis
- 4. Poly 88/8813 Users Group Newsletter
- 5. Software exchange.

1. LA Apple Users Group

- 9513 Hindry Pl, Los Angeles CA 90045
- Philip A Wasson, (213) 649-1428

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- 2. 3816 Albright Ave, Los Angeles CA 90066
- 3. Larry Goga, (213) 398-6086
- 5. This club is open to all owners of 6502-based computers including KIM, SYM, and AIM. PET and Apple owners are also welcome.
- 1. SuperLetter
- 2. Abrams Creative Services, 369 S Crescent Dr, Beverly Hills CA 90212
- 3. (213) 277-1588
- 5. Newsletter for SuperBrain users.
- 1. OSI Users Independent
- 2. 6061 Lime Ave #2, Long Beach CA 90805
- 3. Charles Curley, (213) 422-3673
- 4. OSI Users Independent Newsletter
- 5. OSI computers and software.
- 1. ELF of the Valley
- 2. 2670 Calle Abedul, Thousand Oaks CA 91360
- 3. Richard Cox, (805) 492-4128
- 5. RCA 1802 microcomputers.
- 1. Compucolor/Intecolor Users Group
- 5250 Van Nuys Blvd, Van Nuys CA 91401
- 3. Stan Pro, (213) 788-8850
- 4. Bulletin
- 5. We are an international group of color-computer users, with over 1000 programs in our library.
- 1. The Cursor Group
- 2. POB 266, North Hollywood CA 91603
- 4. The Cursor
- 5. User group of the Bally Arcade.
- 1. ET-3400 Users Group
- 2. 11231 Oak St, El Monte CA 91731
- 3. Charles Van Dyke, (213) 443-2237; CompuServe acct 70250,413

- 1. San Diego Heath User's Group
- 2. 12202 Kingsford Ct, El Cajon CA 92021
- 3. Jim Quinn, President, (714) 561-2540; Cliff Dudley, Secretary, (714) 697-8796
- 4. Coming soon
- 5. Special interests: the exchange of ideas, information, and assisting Heath computer users.
- 1. CIE (Computer Informa-

- tion Exchange)
- 2. POB 158, San Luis Rev CA 92068
- 3. Bill McLaughlin, (714) 757-4849
- 4. CIE People's Software News
- 5. Special interests: TRS-80.
- 1. Apple for the Teacher
- 2. 9525 Lucerne St, Ventura CA 93004
- 3. David Miller, Editor,

- (805) 647-1063: Ted Perry, President, (916) 961-7776
- 4. Apple Educators' Newsletter
- 5. Education using Apple II microcomputers.
- 1. International Apple Core
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- 1. Homebrew Computer Club
- 2. POB 626, Mountain View CA 94042
- 3. Robert Reiling, (415) 967-6754
- 4. Homebrew Computer Club Newsletter
- 5. Information exchange on all systems.
- 1. Proteus
- 1690 Woodside Rd, 219, Redwood City CA 94061
- 1. FORTH Interest Group
- 2. POB 1105, San Carlos CA 94070
- 3. Roy Marteus, (415) 962-8653
- 4. FORTH Dimensions
- 5. The FORTH language.
- 1. San Francisco Apple Core
- 2. 1515 Sloat Blvd, Suite 2, San Francisco CA 94132
- 3. Randy Fields, (415) 775-7965
- 4. Cider Press
- 5. Apple computers.
- 1. CUssP
- POB 784, Palo Alto CA 94302
- 3. Dave Dameron, Editor
- 4. CUssP Newsletter
- 5. Cromemco computers and systems.
- 1. INSUA (International North Star User's Association)

- POB 1318, Antioch CA 94509
- 3. William Banaghan
- 4. The Compass
- 5. For North Star computer users.
- 1. Arcadian
- 3626 Morrie Dr, San Jose CA 95127
- 3. R Fabris, (408) 742-6048 (8 AM to 4 PM) or (408) 258-4586 (6 to 10 PM)
- 5. For the Bally/AstroVision Arcade.
- 1. CUE (Computer-Using Educators)
- Independence High School, 1776 Education Park Dr, San Jose CA 95133
- 3. Don McKell, (408) 926-7378
- 4. Bimonthly newsletter
- 5. Computers in education.
- 1. Pascal/Z Users Group
- 2. 7962 Center Pky, Sacramento CA 95823
- 5. The purpose of our group is to encourage the use of Pascal.
- 1. 68XX(X) User Group
- POB 18081, San Jose CA 95158
- 3. Ray Boaz, (408) 269-9522
- All 68XX(X) microcomputers and related hardware and software.
- 1. SYM-1 Users Group
- POB 315, Chico CA 95927

- 3. H R Luxenburg, (916) 895-8751
- 4. SYM-Physis
- Graphics, voice, music, word processing, and intercomputer communications for the SYM-1.
- 1. Group/380
- 2. POB 1131, Mt Shasta CA 96067
- 3. Mokurai Cherlin
- 4. Group/380 News
- 5. IBM 370-compatible microcomputers.
- 1. The Aloha Computer Club
- POB 4470, Kailua HI 96734
- 3. Roger Wickenden, President, (808) 262-4673
- 4. The Debugga
- Anything to do with microcomputers.
- 1. Z80 Microfans—A Sorcerer Users Group
- 2. POB 12504, Portland OR 97212
- 3. C Douglas Auburg, Editor, (206) 694-7769, evenings
- 4. Z80 Microfans Newsletter
- Special interests: sharing problems, tips, and solutions in the use of the Exidy Sorcerer.
- 1. Portland Computer Society Inc
- POB 17371, Portland OR 97217
- 3. Neal J Bonome, (503) 654-5932
- 4. Portland Computer Society Newsletter
- 5. Information exchange for

- all types of microcomputers.
- 1. Salem Area Computer Club
- POB 7715, Salem OR 97303
- 3. Kenneth Ernst, (503) 393-1173
- 4. SACC Newsletter
- Users groups: Apple, TRS-80, PET, and VisiCalc.
- 1. Home Computers
- POB 616, Silverton OR 97381
- 5. General information on personal computers.
- 1. Atari Computer Enthusiasts
- 2. 3662 Vine Maple Dr, Eugene OR 97405
- 3. M R Dunn, Editor,
- 4. A.C.E. Newsletter
- This group is dedicated to the use of Atari microcomputers.
- 1. Hex Users Group
- 36012 Military Rd S, Auburn WA 98002
- Charles Worstell, (206) 927-6038
- Newsletter on an irregular basis
- Special interests: 6800 and 6809 small systems.
- 1. PN HUG (Pacific Northwest Heath Users Group)
- 2. c/o POB 993, Bellevue WA 98009
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- Special interests: Heath H-8 and H-89 microcomputers.
- 1. NW PET Users Group
- 2. 2565 Dexter N #203, Seattle WA 98109
- 3. Richard Ball, (206) 284-9417
- 4. Newsletter
- 5. PET users group.
- 1. Apple Puget Sound Program Library Exchange

1. Computer Education

Group of Victoria

3. Greg Johnstone, (03)

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2. POB 245, Niddrie, Vic-

toria 3042, Australia

5. Educational uses of com-

1. Brazilian Microcomputer

- 304 Maine Ave S, Suite 300, Renton WA 98055
- 3. Dick Hubert, (206) 271-4514
- 4. Call—A.P.P.L.E.
- Everything related to the Apple II.
- 1. SPOHUG (Spokane Heath Users Group)
- RFD #1, Box 676, Spokane WA 99204
- 3. Charles K Ballinger, President, (509) 448-9727
- 4. SPOHUG Newsletter
- 5. Special interests: Heath H-8 and H-89 computers.

- 1. I-SUG
- 2. POB 1542, St Catharines, Ontario, L2R 7J9, Canada
- 5. Interested in Exidy Sorcerer microcomputers.
- Kitchener Waterloo Microcomputer Club
- Reading Room E2-3354, Electrical Engineering Department, University of Waterloo, Waterloo, Ontario, N2L 3G1, Canada
- 3. Roger Sanderson, work (519) 885-1211, ext 3815
- 5. Special interests: 6800 and 6809 SwTPC systems.
- 1. OSMIE (Ontario Society for Microcomputers in Education)
- Unit for Computer Science, McMaster University, Hamilton, Ontario, L8S 4K1, Canada
- 3. N Solntseff, (416) 525-9140, ext 4689
- All educational uses of microcomputers.
- 1. The Ottawa Computer
- POB 5691, Station F, Ottawa, Ontario, K2C 3M1, Canada
- 3. John Mainwaring, President, (613) 725-9441; or Dennis Tubie, Secretary, (819) 561-1645
- 4. OCG Newsletter
- Special interests: microprocessors and computer bulletin board.

- 1. TRACE (Toronto Region Association of Computer Enthusiasts)
- 2. POB 6922, Station A, Toronto, Ontario, M5W 1X6, Canada
- 3. Ross Cooling, (416) 488-3314
- 4. TRACE
- 1. CPE (Central Program Exchange)
- Department of Computing & Mathematical Sciences, The Polytechnic, Wulfruna St, Wolverhampton, WVI 1LY, England
- 3. Judith Brown, 0902 27371, ext 93
- 4. Program Exchange
- Microcomputer usage in schools and educational computer-aided learning.
- 1. North London Hobby Computer Club
- c/o D.E.C.E. Polytechnic of North London, Holloway Rd, London N7 8DB, England
- 3. Robin Bradbeer, 01-607-2789
- 4. Gigo
- 5. Special interests: business, homebrew, and games workshops. PET users group.
- 1. Microtel Club
- 2. 9, rue Huysmans 75006 Paris, France
- 3. M Perdrillat, 33 (1) 544 70 23
- 4. Microtel-Infos
- This group is interested in microcomputers and telecommunications.

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- Club
 2. Rua Sambaiba, 516,
 Leblon, Rio de Janeiro
 22450, Brazil
- 3. Douglas Gilson, 274-2439
- Special interests: exchanging programs and ideas with other clubs.
- 1. Apple's British Columbia Computer Society
- 2. #101-2044 W 3rd Ave, Vancouver, British Columbia, V6J 1L5, Canada
- 3. Gary Little, (604)

731-7886

Foreign Clubs and Newsletters

- 4. Applegram
- 5. Apple II microcomputers.
- 1. Apple-Can
- 2. POB 696, Station B, Willowdale, Ontario, M2K 2P9, Canada
- 3. Louis H Milrad, (416) 961-6691 or 223-0599
- 4. Yes
- 5. All areas concerning microcomputers.
- 1. Association of Computer Experimenters
- c/o B Murphy, 102 Mc-Craney St, Oakville, Ontario, L6H 1H6, Canada
- 3. B Murphy, (416) 845-1630
- 4. Ipso Facto
- Special interests: CDP 1802 microprocessorbased hobby computers.

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VOICETEK

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Clubs and Newsletters_

- 1. Japan Microcomputer Club
- 2. Rm 313, 3-5-8, Shibakoen, Minato-Ku, Tokyo 105, Japan
- 3. Keigo Aono, Director 03-438-1869
- 4. Microcomputer Circular
- This is the largest, nonprofit, nationwide group in Japan. An English-language version of the club's newsletter is available.
- 1. Microcomputer Club
- 2. Fte de Quijote #5, Tecamachalco, Mexico 10-D F, Mexico
- 3. Alfredo Buzali, (905) 589-2279
- 4. Bulletin
- 5. Primarily concerned with the Apple computer.

- 1. HCC (Hobby Computer Club)
- 2. Christinastraat 171, 5 615 RK Eindhoven, Netherlands
- 4. Hobby Computer Club Nieuwsbrief
- The goals of the HCC are to increase contacts between computer amateurs and to exchange ideas and experiences.
- 1. Club de Computación Lampas de Carabobo
- Apartado 716, Valencia, Venezuela 2001A, Venezuela
- 5. Use of microcomputers in civil engineering, basic sciences, and administration.

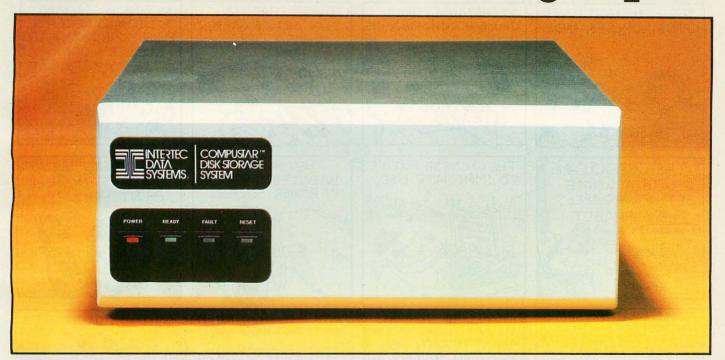
Answers to MicroShakespeare Quiz

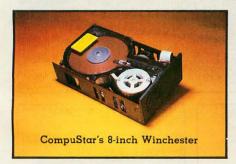
1 - m	6 - 0	11 - i	16 - e
2 - j	7 - b	12 - c	17 - t
3 - a	8 - q	13 - r	18 - k
4 - f	9 - 1	14 - g	19 - n
5 - h	10 - s	15 - p	20 - d

Number of Correct Matches	MicroShakespeare Rating					
20	Hit "START" with confidence.					
17 - 19	One short debug session and you're home free.					
13 - 16	Check your system monitor.					
9 - 12	Must have mixed up the pinouts.					
5 - 8	Blame it on a power surge.					
4 or fewer	Back to collecting stamps.■					

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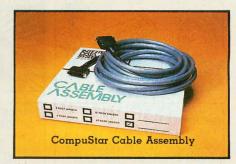
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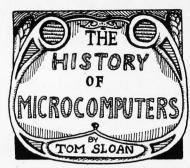
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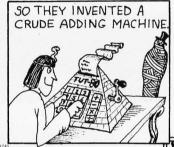


LETS SEE NOW .. THE JI44 IS ... UH, HMM WELL, IT MUST BE 10.

COUNTING REMAINED THAT WAY UNTIL SOME GREAT SUMERIAN DISCOVERED THAT NUMBERS CAN EXIST HIGHER THAN 10.



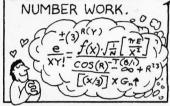
THE EGYPTIANS LOVED LARGE NUMBERS, AND ...

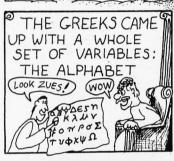


IT EVEN HAD ITS OWN SET OF GRAPHIC CHARACTERS.



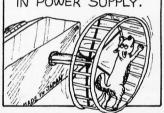
AS TIME PROGRESSED SO DID MAN'S NEED FOR EVEN MORE COMPLICATED NUMBER WORK.





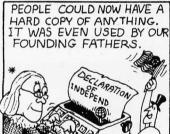


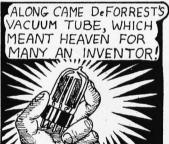
THEN PASCAL INVENTED THE BUILT IN POWER SUPPLY.



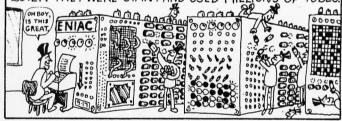
GUTENBERG INVENTED THE FIRST MOVABLE PRINT, HEAD.



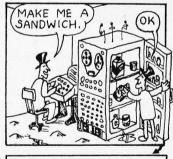




WITH THAT, THE FIRST TRUE DIGITAL COMPUTERS WERE BUILT. THEY WERE GIANT AND USED MILLIONS OF TUBES



BUT WHEN REPLACING TUBES BECAME MORE COSTLY THAN THE FIGURING WAS WORTH, SOLID STATE TECHNOLOGY TOOK OVER. SO INSTEAD OF MASSIVE COMPUTERS FILLING UP AN ENTIRE FLOOR, THEY WERE BUILT TINY. ABOUT THE SIZE OF A REFRIGERATOR. (.0000.



INSTEAD OF PAPER. SOMEONE GOT THE IDEA TO ADD A T.V.

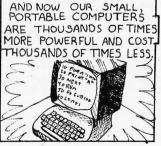


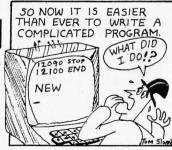
DESPITE THEIR SMALL SIZE, THEY STILL WERE NOT QUITE SMALL ENOUGH FOR HOME USE.











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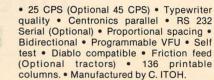
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Software Review

Three Versions of APL

Gregg Williams, Senior Editor BYTE POB 372 Hancock NH 03449

When BYTE magazine published its APL language issue in August 1977, APL was far beyond the capabilities of any microcomputer. To show how rapidly things have evolved since then, the Digital Group, in that same issue, was advertising a 32 K-byte static-memory board for \$995, and another advertisement began, "Introducing Apple II...." Times have changed: 32 K bytes of dynamic memory, now commonly used in several major microcomputer lines, can be bought for less than \$120—and Apple is one of the oldest computer lines in the industry.

Times have changed for APL as well: several companies have announced software and hardware supporting this unique programming language. This review compares three versions of APL: Softronics APL, Ramware APL80 for the Radio Shack TRS-80, and Vanguard APL/V80. (For additional information, see the "At a Glance" boxes. Tables 1 thru 4 give timing comparisons and further information.)

Softronics APL: I/O Options and Documentation

Softronics APL runs on any Z80-based computer that supports at least 44 K bytes of memory and the CP/M operating system. It was written by Eric Mueller of Softronics, who, in 1977, authored a subset of APL called EMPL for 8080-based microcomputers. Softronics APL (Version 2.3C), which sells for \$350, has both good and bad features; a summary is given in table 2.

The most welcome feature of Softronics APL is the ability to use it with several types of keyboards and display devices. The default mode of operation is for the software to respond to a standard ASCII (American Standard Code for Information Interchange) terminal through standard CP/M input and output routines. Three other modes allow the user to use an assortment of APL-type devices.

For those of us who do not have several thousand extra dollars to spend on an APL-type I/O (input/output) device, the ASCII mode of Softronics APL is very welcome. In this mode, all APL characters that are not on a normal keyboard are replaced by either a single key (eg: an underline character to replace the APL assignment arrow) or a 3-character mnemonic (eg: \$TP for the transpose operator or \$RO for the Greek rho symbol). Although some users object to this arrangement, my reaction to running Xerox APL for an extended period, using such mnemonics, was one of gratitude—better this

APL than no APL at all.

Listing 6 shows the output of the APL function CIRCLE. Listing 3a shows the output with slight changes in regular APL notation. I have also found that by changing the value of the system variable □CS, you can cause the APL mnemonics to be displayed with angle brackets around them instead of the preceding dollar signs—on printout only (ie: not input). For example, you will still have to type in \$RO for the APL reshape operator, but it will be displayed to the screen or printer as <RO>. This is a nice feature that adds to the readability of APL programs printed in ASCII mode.

Provisions are also made for using Softronics APL with the two most prevalent types of APL terminals (*bit-pairing* and *typewriter-pairing* terminals). Softronics APL begins executing in the ASCII mode but can be converted to APL terminal mode by assigning a new value to the system variable □CS, or it can be modified to begin executing in terminal mode by making a 1-byte patch to the APL.COM machine-language file. Nonstandard terminals or video boards can be interfaced by adding user-supplied input and output machine-language subroutines. The manual explains what routines need to be written and where they should be placed in memory.

Finally, the manual gives documentation on still another I/O option: the use of APL input and output through a video board with a programmable character generator. The documentation includes the software driver (which works with an Objective Design Inc character generator), a Kent-Moore Alpha-VDM-II video display board, and a listing that defines all APL special characters for a character generator as a series of hexadecimal numbers. All this code is included in the APL.COM file.

The ease with which I understood these four display options is an indication of the quality of the documentation. The Softronics APL documentation is the best of the three packages reviewed here. It includes a short tutorial on APL for the complete novice, a description of all functions, sample programs (including APL defined functions that simulate certain APL operators not defined in machine language), and several useful appendices. One section of the documentation, "Bugs and Common Perplexing Error Messages," is a great time saver. It is extremely helpful in explaining some quirks of Softronics APL and how to circumvent them. This section saves the user from

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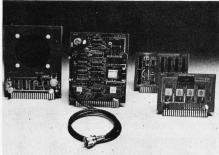


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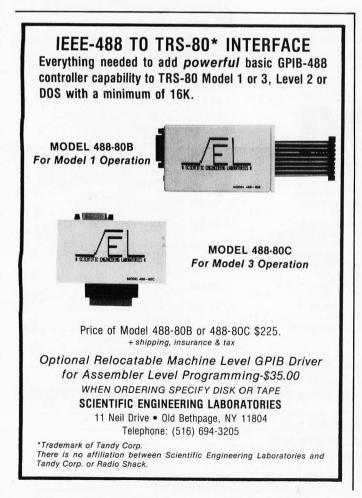
spending quite a bit of time swearing that the language "just doesn't work right."

Softronics APL: Some Problems

Despite its excellent performance in other areas, Softronics APL (Version 2.3C) has a number of deficiencies that range from minor annoyances to critical defects. The most serious defect is that Softronics APL does not notify the user of an error situation. Any computation that has a result over 9.2×10^{18} is replaced by a seemingly random value between 10^{18} and 10^{19} . The low limit on computation size is *not* what makes this error dangerous; rather, the danger lies in the language substituting an inaccurate answer and *not* stopping the computation with an error message.

A second problem with Softronics APL is that it responds with the message SYNTAX ERROR to any number over 7 digits long. I feel that the inability of this language to accept a longer number by rounding it off and, when necessary, putting it into scientific notation is a serious defect.

Many numeric operations that should come out "even" result in numbers ending in ...9999 or ...9997. For example, any variable assigned either the value 0.1 or 1/10 is printed as .099999. The dyadic power function has, for integral exponents, a cumulative round-off error that results in some incorrect answers. For example, 58 is calculated to be 390,622 (it is 390,625) and 312 is calculated to be 531,436 (it is 531,441), with higher powers also being incorrect.



When using the power function for fractional powers, such as square roots, the results seem to be one or two units off in the least significant digit. Even though 6 significant digits are given in all calculations, I would recommend using only 5 significant digits when using the dyadic power function to calculate a root.

The trigonometric functions, such as sine, cosine, tangent, and arctangent, agree with the results found in the Chemical Rubber Company's *CRC Standard Mathematical Tables*. However, the arctangent function seems to work with a scalar (ie: a single value) but not with a vector (ie: a one-dimensional array of values).

Softronics APL still lacks several useful functions that are found in the more expensive Vanguard APL: arccosine, arctangent, and all hyperbolic trigonometric functions; rotation on three-dimensional and higher matrices; the grade-up and grade-down functions; and the deal (ie: dyadic question-mark) function. Other,

At a Glance_

Name

Softronics APL, Version 2.3C

Type of Software Package

Version of APL programming language

Manufacturer

Softronics, 35 Homestead Ln, Roosevelt NJ 08555

Price \$350

Format

8-inch standard CP/M floppy disk

Language Used 8080 machine language

Computer Needed

An 8080-, 8085-, or Z80-based computer with at least 44 K bytes of programmable memory, running the CP/M operating system

Documentation

112 pages, 22 by 28 cm (8½ by 11 inches)

Audience

APL users, programming language enthusiasts

At a Glance -

Name

APL80 (by Phelps Gates)

Type of Software Package

Version of APL programming language

Manufacturer

Ramware, 6 South St, Milford NH 03055 (603) 673-5144

Price \$39.95

Format

5-inch floppy disk

Language Used Z80 machine language

Computer Needed

Radio Shack TRS-80 Model I with one floppydisk drive, Level II BASIC, and 32 K bytes of memory

Documentation

Twenty pages, 13 by 20 cm (5 by $7\frac{3}{4}$ inches)

Audience

APL users, programming language enthusiasts

Comments

Cassette-tape version with 25% fewer features available for 16 K TRS-80 at \$14.95



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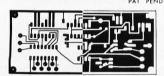
more advanced operators that are also missing are not mentioned here. See table 2 for a more complete definition of the language.

Ramware APL80

In its version of APL for the Radio Shack TRS-80 Model I, Ramware of Milford, New Hampshire, has made available a remarkable product. When I first saw the advertisements for the tape version of APL80, its low price (\$14.95) led me to dismiss it as some kind of toy, probably written in BASIC and too slow to be useful. Even though the tape version has about 25% fewer features than the more expensive disk version (\$39.95), it is still written in Z80 machine language and is a fairly usable version of the language. Author Phelps Gates has reason to be proud of this package.

Table 3 lists the operators available within APL80. The fullness of the language is due to the use of the ROM (read-only memory) modules implementing Level II BASIC. Because the author was able to use the numerical routines from Level II BASIC, much of the work of creating an entire programming language had been done for him, and he could concentrate on making it behave like APL. (APL80 has been tested and found to work on the newer TRS-80s that have Level II BASIC in two rather than three ROM devices. Until a correction can be made to the current version of APL80, however, the down-arrow symbol used for the APL drop and gradedown operations must be displayed by simultaneously Text continued on page 196

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At a Glance_

Name of System Vanguard APL/DTC (desk-top computer)

Manufacturer Vanguard Systems Corporation, 6812 San Pedro, San Antonio TX 78216 (512) 828-0554

Price \$7995

Terminal Dimensions 32 by 45.5 by 53.5 cm (121/2 by 18 by 21 inches)

Computer Dimensions 19 by 51 by 43 cm (71/2 by 20 by 17 inches)

Processor Z80, 8-bit

System Clock Frequency 4 MHz

Memory 80 K bytes of static memory (34 K bytes left for APL workspace)

Mass Storage Two quad-density 5-inch floppy-disk drives

Features

APL/ASCII keyboard and 12-inch APL/ASCII memory-mapped video display of twenty-four 80-character lines housed in separate video terminal enclosure: display of all APL characters

Software Included CP/M operating system. APL/DTC software

Hardware Options Communications option (Hayes Microcomputer Products Micromodem plus special software); high-resolution (256-by-240 black-andwhite or 128-by-120 sixteen-gray-level) graphics; letter-quality APL/ASCII printer, realtime clock.

Software Options APL * PLUS file system simulator

Audience APL users, programminglanguage enthusiasts

At a Glance_

Name

Vanguard APL/V80

Type of Software Package Version of APL program-

ming language

Manufacturer

Vanguard Systems Corporation, 6812 San Pedro, San Antonio TX 78216 (512) 828-0554

Price \$500

Format CP/M or CDOS operating system, 5-inch

Language Used Z80 machine language

or 8-inch disk

Computer Needed Computers with at least 48 K bytes of programmable memory; a Z80 processor card; at least one floppy-disk drive

Documentation

Seventy-six pages, 22 by 28 cm (8½ by 11 inches)

Audience

APL users, programming language enthusiasts

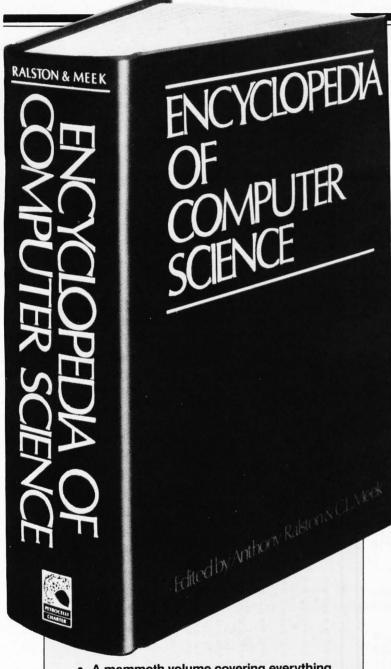
Features

APL defined functions (programs) simulate some APL functions, APL * PLUS file system, and other functions

Comments

This version is identical to the software reported on for the APL/DTC computer, except for the reduced workspace size and the availability of the inner product function as a defined function.

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* Bibliographies * Names and addresses

for microcomputer ★ Fantasy game characters

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Listing 1: Listing of the APL function SETUP. This routine defines certain variables used in the execution of benchmark programs.

```
∇ SETUP
[10] A+10 10p:100
[20] B+QA
[30] C+10×1 • RA
[40] D \leftarrow A \times (\circ 2) \div 100
[50] E+110
[60] F+1000 365 24 60 60
[70] RA+,A
[80] RB+,B
[90] M3D+2 5 10pRA ∇
```

Listing 2: Listing of the APL function TIME. When this routine is used as a benchmark program, the function to be tested replaces each occurrence of the phrase (EXP) on lines 10 thru 60. (See table 1.)

```
∇ TIME N;LP
[10] I.P+0
[20] BGN: (EXP)
[30] (EXP)
[40] (EXP)
[50] (EXP)
[60] (EXP)
[70] \rightarrow (N>LP+LP+1)/BGN
[80] 'DONE '; N×5; ' TIMES'
[90] 'UNIT TIME IS '; (÷N×5)×□;
     ' SECONDS PER ITERATION' ♥
```

Listing 3: Listing and sample execution of the APL function CIRCLE. Listing 3a shows the function, which has the purpose of adding a set value to all matrix elements that fall within an imaginary circle with a given center and radius. Listing 3b shows a 10 by 10 array filled with zeros and, below it, the same circle after execution of the statement $B \leftarrow (6\ 5\ 4\ 8)$ CIRCLE A. On one of the printers used to generate these listings, the backarrow character, ←, appears as an underscore, __

```
∇B←AR CIRCLE A;RD;ROW;COL
[10]
       AR CONTAINS: ROW COORD, COL COORD, RADIUS, VALUE ADDED
[20] B+A
[30] ROW \leftarrow AR[1] - AR[3] + 1
[40] NEXTROW: ROW+ROW+1
[50] COL \leftarrow AR[2] - AR[3] + 1
[60] NEXTCOL: COL+COL+1
[70] \rightarrow (AR[3] \leq (((ROW-AR[1])*2)+(COL+AR[2])*2)*0.5)/ENDLP
[80] B[ROW;COL]+B[ROW,COL]+AR[4]
[90] ENDLP: +(COL<AR[2]+AR[3])/NEXTCOL
[100] \rightarrow (0, NEXTROW)[1+ROW\leftarrowAR[1]+AR[3]]\vee
0
    0
         0
              0
                   0
                        0
                             0
                                  0
                                       0
    0
         0
              0
                   0
                        0
                             0
                                  0
                                       0
                                            0
0
    0
         0
              0
                   0
                             0
                                  0
                                       0
                        0
0
    0
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              0
                   0
                        0
                             0
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0
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    0
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                        0
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    0
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              0
                   0
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                                       0
                                            0
                        0
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    0
         0
              0
                   0
                        0
                                  0
0
    0
         0
              0
                   0
                        0
                             0
                                  0
                                       0
   B_(6 5 4
              8)
                  CIRCLE A
    0
              0
                        0
                             0
                                  0
                                       0
         0
              0
                   8
                        0
                             0
                                  0
                                       0
                   8
                                  0
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                                            0
              8
                        8
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              8
                   8
                        8
                             8
                                  8
0
                                  8
                                       0
                                            0
    8
         8
              8
                   8
                        8
                             8
0
    8
```

0 0

0 0 8 8 8 8

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Listing 4: Listing and sample execution of the APL function TRANS. Listing 4a shows the function, which translates a numeric array similar to the one in listing 3b to a character array that reflects the contents of the numeric array. Listing 4b shows the result of executing TRANS B, where B is the matrix in the lower half of listing 3b.

∇B+TRANS A;AA;MX;MN;MAXX;CHAR

[10] CHAR+'LMNOPQRSTUVWXYZ-123456789ABCDEF+*#'

[20] MN+L/AA+,A

[30] MX+[/AA

[40] MAXX+(MX[-MN)÷15

[50] AA-[0.5+16+AA÷MAXX

[60] B+(ρA)ρCHAR[AA] ∇

Listing 5: Listing of the APL function IVER. This function, written by Kenneth Iverson (the inventor of APL), will generate a vector of all prime numbers up to and including the scalar A. (A must be greater than or equal to 7.)

∇ *B←IVER A B←*(2=+/\(\partial_0=(\(\partial_A\)\)\)\\
∇

TRS-80 (Level II) STOP PLAYING GAMES OTHERS Calculate odds on HORSE BACES with ANY COMPU-TER using BASIC. SCIENTIFICALLY DERIVED SYSTEM really works. TV Station WLKY of Louisville, Kentucky used this sytem to predict the odds of the 1980 Kentucky Derby. See the Wall Street Journal (June 6, 1980) article on Horse-Handicapping. This system was written and used by computer experts and is now being made available to home computer owners. This method is based on storing data from a large number of races on a high speed, large scale computer. 23 factors taken from the "Daily Racing Form" were then analyzed by the computer to see how they influenced race results. From these 23 factors, ten were found to be the most vital in determining winners. NUMERICAL PROBABILITIES of each of these 10 factors were then computed and this forms the basis of this REVOLUTIONARY NEW ■ SIMPLE TO USE: Obtain "Daily Racing Form" the day before the races and answer the 10 questions about each horse. Run the program and your computer will print out the odds for all horses in each race. COMPUTER POWER gives you the advantage! ■ YOU GET: 1) TRS-80 (Level II) or Apple Cassette 2) Listing of BASIC program for use with any computer 3) Instructions on how to get the needed data from the "Daily Racing Form". 4) Tips on using the odds generated by the program. 5) Sample form to simplify entering data for each race -MAIL COUPON OR CALL TODAY-3G COMPANY, INC. DEPT. BT (503) 357-9889 RT. 3, BOX 28A, GASTON, OR 97119 Yes, I want to use my computer for FUN and PROFIT. Please send me programs at \$24.95 each. I need a TRS-80 Cassette or Apple Cassette. Enclosed is: check or money order Master Charge Visa Card No Exp. date NAME ADDRESS STATE START USING YOUR COMPUTER FOR FUN and PROFIT

Listing 6: Listing of the APL function CIRCLE as generated by Softronics APL using a non-APL video terminal. APL functions can be printed on a standard printer through the use of mnemonic phrases, which begin with a \$ sign. The backarrow appears here as an underscore.

\$DL B_AR CIRCLE A; RD; ROW; COL [1] SLP AR CONTAINS: ROW & COL COORD, RADIUS, VALUE ADDED [2] ST.P [3] SLP (EG: (6 5 4 9) CIRCLE A ADDS TO ARRAY A CIRCLE OF [4] SLP VALUE 9 AND RADIUS 4, WITH CENTER AT (6,5)) [5] \$LP [6] BA [7] ROW_AR[1]-AR[3]+1 NEXTROW: ROW_ROW+1 [8] [9] COL_AR[2]-AR[3]+1 [10] NEXTCOL:COL_COL+1 [11] \$GO ((AR[3]*2)<((ROW-AR[1])*2)+(COL-AR[2])*2)/ENDLP B[ROW; COL]_B[ROW; COL]+AR[4] [12] [13] ENDLP:\$GO (COL\$LE AR[2]+AR[3])/NEXTCOL [14] \$GO (0,NEXTROW)[1+ROW<AR[1]+AR[3]]

Text continued from page 192:

pressing three keys: the *shift* key, the *down-arrow* key, and the Z key.)

Because Ramware APL80 has almost all the capabilities of Level II Disk BASIC, it has some functions and features that the other versions reviewed here do not; several examples are: single-precision or double-precision variables, inverse trigonometric functions, exponents, logarithms, and character editing within a line. Even in the benchmarks (see table 1), this version does fairly well against the other two versions when you consider the differences in price (\$39.95 vs \$350 and \$500) and in processor speed (the TRS-80 is running at 1 MHz, while the other two are running the same type of Z80 processor, but at 4 MHz).

The method used to represent APL on an unmodified TRS-80 is odd, but it is probably the best way that could Text continued on page 204

OPERATION	UNIT TIME TO PERFORM OPERATION, SECONDS				
	SOFTRONICS APL	RAMWARE APL80	VANGUARD APL/DTC SOFTWARE		
Q A ÷ B	0.79	4.6	1.2		
Q - A > B	0.48	0.42	0.091		
Q ← B	0.059	0.051	0.012		
Q - 2 O D	5.0	2.9	8.6		
Q ♥ C	140.	11.	3.1		
Q - F T 100000000	NA	0.61	0.13		
Q 50 TRA	0.086	0.18	0.014		
Q ← 🗦 N1	180.	NA	66.		
Q ← 4 Ф[1] M3D	NA	0.74	1.8		
Q E °. + E	0.41	0.31	0.082		
Q-+/C	0.25	0.25	0.19		
CIRCLE	160. *	230. *	150.		
TRANS	9.0 *	28. *	11.		
IVER	28.	160. *	120.		

Table 1: Timing results of APL benchmark programs. For details on this and tables 2 thru 4, see the "Notes on APL Benchmarks" text box on page 204.

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13 CHECKBK1

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15 MULTMON

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18 RRCONST

19 EFFECT

20 FVAL

21 PVAL 22 LOANPAY

23 REGWITH

24 SIMPDISK

25 DATEVAL

26 ANNUDEF

27 MARKUP

28 SINKFUND

29 BONDVAL

30 DEPLETE

31 BLACKSH

32 STOCVAL1

33 WARVAL

34 BONDVAL2 35 FPSFST

36 BETAALPH

37 SHARPE1

38 OPTWRITE

39 RTVAL

40 EXPVAL 41 BAYES

42 VALPRINF

43 VALADINF

44 UTILITY

45 SIMPLEX

46 TRANS 47 EOQ

48 QUEUE1

49 CVP

50 CONDPROF

51 OPTLOSS

52 FQUOQ

NAME

53 FQEOWSH 54 FOFOOPB

55 QUEUECB

56 NCFANAL

57 PROFIND Profitability index of a project

Interest Apportionment by Rule of the 78's

Annuity computation program Time between dates

Day of year a particular date falls on

Interest rate on lease Breakeven analysis

Straightline depreciation Sum of the digits depreciation

Declining balance depreciation Double declining balance depreciation

Cash flow vs. depreciation tables Prints NEBS checks along with daily register

Checkbook maintenance program

Mortgage amortization table

Computes time needed for money to double, triple, etc.

Determines salvage value of an investment Rate of return on investment with variable inflows

Rate of return on investment with constant inflows

Effective interest rate of a loan

Future value of an investment (compound interest)

Present value of a future amount Amount of payment on a loan

Equal withdrawals from investment to leave 0 over

Simple discount analysis

Equivalent & nonequivalent dated values for oblig.

Present value of deferred annuities % Markup analysis for items

Sinking fund amortization program

Value of a bond Depletion analysis

Black Scholes options analysis

Expected return on stock via discounts dividends

Value of a warrant Value of a bond

Estimate of future earnings per share for company

Computes alpha and beta variables for stock Portfolio selection model-i.e. what stocks to hold

Option writing computations

Value of a right

Expected value analysis

Bayesian decisions

Value of perfect information Value of additional information

Derives utility function

Linear programming solution by simplex method

Transportation method for linear programming Economic order quantity inventory model

Single server queueing (waiting line) model Cost-volume-profit analysis

Conditional profit tables Opportunity loss tables Fixed quantity economic order quantity model

As above but with shortages permitted As above but with quantity price breaks

Cost-benefit waiting line analysis Net cash-flow analysis for simple investment

Cap. Asset Pr. Model analysis of project Circle 133 on inquiry card.

59 WACC Weighted average cost of capital

60 COMPBAL True rate on loan with compensating bal. required

61 DISCBAL True rate on discounted loan 62 MERGANAL Merger analysis computations 63 FINRAT Financial ratios for a firm

64 NPV Net present value of project 65 PRINDI AS

Laspeyres price index Paasche price index 66 PRINDPA

67 SEASIND Constructs seasonal quantity indices for company 68 TIMETR Time series analysis linear trend

69 TIMEMOV Time series analysis moving average trend 70 FUPRINF Future price estimation with inflation

MAILPAC Mailing list system 72 LETWRT Letter writing system-links with MAILPAC

73 SORT3 Sorts list of names 74 LABEL1 Shipping label maker

75 LABEL2 Name label maker 76 BUSBUD DOME business bookkeeping system

TIMECLCK Computes weeks total hours from timeclock info. In memory accounts payable system-storage permitted 78 ACCTPAY

Generate invoice on screen and print on printer In memory inventory control system Computerized telephone directory

Computes selling price for given after tax amount

82 TIMUSAN Time use analysis 83 ASSIGN Use of assignment algorithm for optimal job assign. 84 ACCTREC

In memory accounts receivable system-storage ok Compares 3 methods of repayment of loans TERMSPAY PAYNET Computes gross pay required for given net

ARBCOMP Arbitrage computations Sinking fund depreciation **DEPRSF** Finds UPS zones from zip code

UPSZONE 91 ENVELOPE Types envelope including return address AUTOEXP Automobile expense analysis

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	Scalar Dyadic Operators, Softronics APL										
	OPERATOR	NAME	MONADIC	DYADIC	СОМ	MENTS	OPERATOR	NAME	MONADIC	DYADIC	COMMENTS
	+	ADD	Y	Y			1	RESIDUE	Υ	Υ	
	-	SUBTRACT	Y	Y			1	FACTORIAL	Y*	Y	Gamma function missing.
	×	MULTIPLY	Y	Y			0	CIRCLE	Y	Y*	Only sin, cos, tan, arctan implemented.
	÷	DIVIDE	Y	Y			< < < > > ≥	LESS THAN, E	TC.	Υ	
	*	EXPONENT	N	Y*	Dyadic version last decimal pl	n innaccurate in lace; see text.	= ≠	EQUAL TO, NOT EQUAL TO		Y	
	\otimes	LOGARITHM	Y	Y			۸V	AND, OR		Y	
	L	FLOOR	Y	Y			A¥	NAND, NOR		Y	
	Γ	CEILING	Y	Y]						
					Nondyadic S	Scalar and Mixe	d Operato	ors, Softronics	APL		
ATOR			OIC	0			ATOR		DIC	O	
OPERATOR		N A M	MONADIC	DYADIC	COMMEN	TS	OPERATOR	N A E	MONADIC	DYADIC	COMMENTS
~		NOT	Y				2	TRANSPOS	E Y	Y*	Dyadic "diagonal" transpose missing.
?		ROLL	Y		Dyadic available unction only.	as defined		ROTATE OR REVERSE	Y	N*	Dyadic function available for vectors and two-dimensional
i	-	IOTA (INDEX)	Y	Y			€	ROTATE	Y	N	matrices only available as defined function.
ρ	1	RHO (RESHAPE)	Y	Y			1	COMPRESS		Y	
,	- 1	RAVEL	Y		Catenation for ve amination.	ectors only; no	+	COMPRESS		N*	Available as / [1] only.
ΤТ	1	DECODE, ENCODE		N			1	EXPAND		N	
. ↑↓		TAKE, DROP		Y			+	EXPAND		N	
ξ		MEMBERSHIP		Υ			φ	EXECUTE	Y		
4 ₺	,	GRADE-UP GRADE-DOWN	N*		Available as defi only.	ned function	Φ	FORMAT	Y*		Converts a vector or array to a
÷		MATRIX DIVIDE OR INVERSE	N*		Both available as ion only.	s defined func-					character string (with embedded carriage return) for printing.
					Cor	nposite Operat	ors, Softr	onics APL			
				œ		и. Ш	<u>~</u>			с. Н	
				OPERATOR	ш	AVAILABLE	OPERATOR	ш		ILABL	
				OPE	NAME	AVA	OPE	NAME		AVAILA	
				f/	REDUCTION	Y	f.(INNER PRO	DUCT	Υ	
				f /	REDUCTION	Y	0.1	OUTER PR	ODUCT	Y	
Not	Notes: "Y" and "N" mean that a given operator is either present in all its forms or totally absent from this verion of APL. "Y*" means that the operator is only partially present in this version. "N*" means that the operator is not present in this version but that part or all of it is avail-										

able through an APL defined function supplied with this version. Further information explaining "Y*" and "N*" is given in the "Comments"

A scalar is an object (number or character) with no dimension. A vector is a string of objects that have one dimension. An array is a

matrix of objects that have two or more dimensions.

Other features: standard APL commands, system functions, and system variables; line editing only of defined functions; PEEK and POKE functions; 8080-type port IN and OUT functions; shared variable mechanism for interaction with disk files (sequential read and write only, in standard CP/M format); mixing of APL data structures (arrays, vectors, scalars) in records of same file; user choice of standard terminal, APL terminal, or video board with programmable character generator; and good documentation.

Other limitations: several much-needed operators are missing (see body of this table) and there is no random access to disk files' character defined functions.

acter-editing of defined functions.

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Scalar Dyadic Operators, Ramware APL80												
		OPERATOR	NAME		MONADIC	DYADIC		OPERATOR	NAME	SIGNOM		COMMENTS
		+	ADD		Y	Y			RESIDUE	Y		Y
		-	SUBTR	ACT	Y	Y			FACTORIAL	Y	· [Y Gamma function missing.
die au		×	MULTI	PLY	Y	Y		0	CIRCLE	Y		Hyperbolic and hyperbolic inverse not defined.
		÷	DIVIDE		Y	Y		< < > >	LESS THAN, ET	c.		Y
		*	EXPON	ENT	N	Y*		= ≠	EQUAL TO, NOT EQUAL TO			Y
	(⊛	LOGAR	ІТНМ	Y	Y		$\wedge\vee$	AND, OR			Assumes nonzero values are equivalent to 1 or true (nonstandard).
		L	FLOOR		Y	Y	97.	A¥	NAND, NOR			Y
		Γ	CEILIN	G	Y	Y						
					Nondya	idic Scalar and	d Mixed		ors, Ramware A	PL80		
ATOR			DIC	O				RATOR		DIC	O	
OPERATOR	NAME		MONADIC	DYADIC	.0	COMMENTS		OPER	N A M	MONADIC	DYADIC	COMMENTS
~	NOT		Y					Ø	TRANSPOSE	Y*	Y*	Monadic transpose is nonstan- dard for 3-dimensional or larger
?	ROLL		Y	Y				Φ	ROTATE OR REVERSE	Y	Y	arrays; dyadic "diagonal" transpose missing.
i	IOTA (IND	DEX)	Y	Y				Θ	ROTATE	N*	N*	Available as ϕ [1] only.
ρ	RHO (RES	SHAPE) Y	Y	Catanatia	on for arraya wa	octors	1	COMPRESS		Y	
	RAVEL		Y	Y*		on for arrays, ve t coordinate on n.		+	COMPRESS		N*	Available as / [1] only.
ΤT	DECODE,	ENCO	DE	Y*	Right arg	ument of encoc scalars only.	de	1	EXPAND		Y	
↑ ↓	TAKE, DR	ROP		Y			#F-7	+	EXPAND		N*	Available as \ [1].
ξ	MEMBERS	HIP		Y				<u> </u>	EXECUTE	N		
↑ ↓	GRADE-UP GRADE-D	OWN	Y			•		Φ	FORMAT	Y*		Sets field width and number of decimal places for future output.
÷	MATRIX D OR INVERS	IVIDE SE	N	N								
						Composite (Onerato	rs Ramy	ware API 80			
4114					۸.		ا			n.		
	TOR				ABLE			TOR		ABLE		
IF U. T. L. I	OPERATOR	NAME			AVAILABLE	COMMENTS	Mar.	OPERATOR	N A M E	AVAILABLE		
	6 /		UCTION		∀		97.		Z INNER PRODUCT	Y		
	f /		UCTION		_	Available as f/[1	1		OUTER PRODUCT	Y		
Notes:									otally absent fro			

"Y" and "N" mean that a given operator is either present in all its forms or totally absent from this version of APL. "Y*" means that the operator is only partially present in this version. "N*" means that the operator is not present in this version but that part or all of it is available through an APL defined function supplied with this version. Further information explaining "Y*" and "N*" is given in the "Comments"

A scalar is an object (number or character) with no dimension. A vector is a string of objects that have one dimension. An array is an

matrix of objects that have two or more dimensions.

Matrix of objects that have two or more dimensions.

Other features: five tutorial programs on APL included in package; standard APL commands, automatic execution of latent expression; tracing of function execution; choice of single (6-digit) or double (15-digit) precision in output; real-time clock, line and character editing of defined functions; print formatting and system control variables(APL I-bar functions); positioning of screen output (equivalent to PRINT @ in BASIC); use of periods and dashes in variable names; PEEK, POKE, and CALL functions; random or sequential access of file records; updating of file records; and mixing of APL data structures (ie: arrays, vectors, scalars) in records of same disk file.

Other limitations: only one assignment operator per line; maximum of thirty-two functions per workspace and 255 lines per defined function; arrays limited to sixty-three dimensions; uses one-letter substitutions for APL operators (but these substitutions are differentiated from normal faxt).

from normal text).

Table 3: Summary of Ramware APL80 features.

The Hard Facts About Software

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Scalar Dyadic Operators, Vanguard APL										
	+ OPERATOR	DD NAME		MONADIC	oyAbic oyAbic	- OPERATOR	ESIDUE	₹ MONADIC	✓ DYADIC	COMMENTS
	-	SUBTRA	СТ	Y	Y	!	FACTORIAL	Y*	Y	Gamma available as a defined function.
	×	MULTIP	_Y	Y	Y	0	CIRCLE	Y	Y*	Hyperbolic, inverse $\sqrt{B^2 - 1}$, $\sqrt{B^2 + 1}$ not defined.
	÷ .	DIVIDE		Y	Y	< < > ≥	LESS THAN, ETC).	Y	
	*	EXPONE	NT	Y	Y	= ≠	EQUAL TO, NOT EQUAL TO		Y	
	\otimes	LOGARI	гнм	Y	Y	۸V	AND, OR		Y	
	L	FLOOR		Y	Y	AV	NAND, NOR		Y	
	Γ	CEILING		Y	Y					
				Nond	lyadic Scalar and Mix	ed Opera	tors, Vanguard	APL		
OPERATOR	NAME	MONADIC	DYADIC		COMMENTS	OPERATOR	NAME	MONADIC	DYADIC	COMMENTS
~	NOT	Y				Ø	TRANSPOSE	Y*	N	Monadic transpose for arrays available as defined function
?	ROLL	Y	Y			Ф	ROTATE OR REVERSE	Y*	Y*	only. Both forms work for vectors
i	IOTA (INDEX)	Y	Y			Θ	ROTATE	N*	N*	only; for all arrays, available as defined functions only.
ρ	RHO (RESHAF	PE) Y	Y	atenatic	on for arrays, vectors,	1	COMPRESS		Y	
,	RAVEL	Y	Y* a	long all	coordinates; lamination as defined function.	1 +	COMPRESS		N*	Available as / [1] only.
ΤT	DECODE, ENC	ODE			ument of encode scalars only.	\	EXPAND		Y	
↑ ↓	TAKE, DROP		Y			+	EXPAND		N*	Available as \ [1] only.
ξ	MEMBERSHIP		Y			φ	EXECUTE	Y		
↑ ↓	GRADE-UP GRADE-DOWN MATRIX DIVID OR INVERSE			oth avai	ilable as defined func-	Φ	FORMAT		Y	Left argument is print width and number of decimal places; right argument is vector or array to be formatted.
					Composite Oper	ators, Var	guard APL			
OPERATOR	NAME	AVALLABLES			COMMENTS		NAME		AVAILABLE?	
f/	REDUCTION	Y				f	.g INNER PROD	DUCT	Y	
f /	REDUCTION	N	3	Availa	able as f / [1] only.		.f OUTER PRO	DUCT	Y	
Notes: "Y" and "N" mean that a given operator is either present in all its forms or totally absent from this version of APL. "Y*" means that the operator is only partially present in this version. "N*" means that the operator is not present in this version but that part or all of it is available through an APL defined function supplied with this version. Further information explaining "Y*" and "N*" is given in the "Comments" column. A scalar is an object (number or character) with no dimension. A vector is a string of objects that have one dimension. An array is a										

A scalar is an object (number of character) with no dimension. A vector is a string of objects that have one dimension. An array is a matrix of objects that have two or more dimensions.

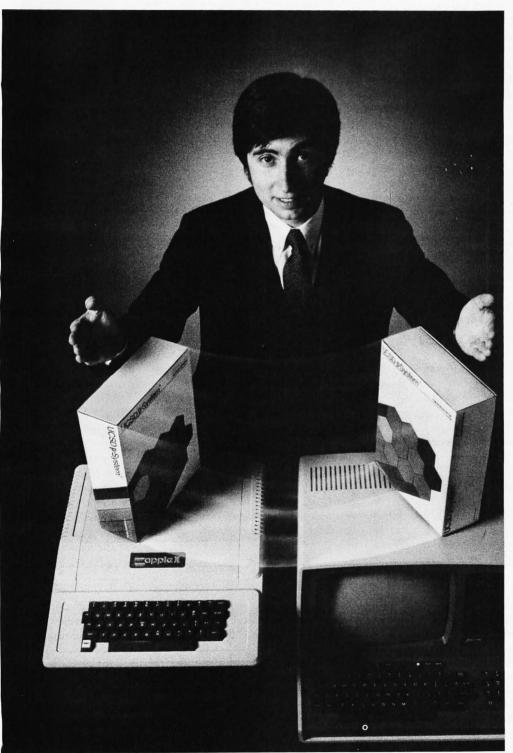
Other features: standard APL commands, system functions, and system variables; line editing only of defined functions; shared variable mechanism for interaction with disk files (sequential and random access); mixing of APL data structures (arrays, vectors, scalars) in records of same disk file; the ability to share with any Z80 I/O port.

Other limitations: only way to use this software with a non-APL terminal or video board uses one-letter substitutions of a standard ASCII character for APL operators (plus these substitutions are not differentiated from normal text); documentation is adequate but terse; no character editing of defined functions.

Table 4: Summary of Vanguard APL/DTC software features.

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Notes on APL Benchmarks

The following information specifies the tests that are run on all versions of APL that are examined at BYTE magazine. Defined function SETUP, shown in listing 1, creates the APL variables that will be used in the tests shown in table 1. A and B are 10 by 10 matrices used in tests like $A \div B$ to perform an operation 100 times with one statement. C is a ten-element vector giving the values from π to 10π . D is a 10 by 10 matrix of trigonometric values. E is a ten-element vector of the values from 1 to 10 (used to test the outer product operator). F is a vector used to convert seconds to years, days, hours, minutes, and seconds in the test F T 100000000, using the encode (T) operator. RA and RB are 100-element vectors made from the elements of matrices A and B. Finally, M3D is a threedimensional array used to test rotation around a nondefault axis.

The function TIME in listing 2 was used in timing the performance of a function. Statements 20 thru 60 are performed N times, with the (exp) in each line replaced by the function being tested (for example, $Q \leftarrow A \div B$). Statement 80 displays the total number of times the function has been performed, while statement 90 requests the number of seconds used in the test (timed by a stopwatch) and displays the time used to perform the function once. Each function is per-

formed five times within TIME to maximize the time spent executing the function when compared to the time spent executing statement 10 and repeatedly executing line 70 N times. In addition, the TIME function was performed with increasing values of N until the unit time agreed to three significant places. The timing values in table 1 are rounded to two significant places.

Three short APL functions, CIRCLE, TRANS, and IVER, are used as benchmarks to grade the performance of an APL implementation in less abstract terms. (See listings 3, 4, and 5.) CIRCLE takes a numeric matrix and adds a set value to all matrix elements in an imaginary circle with a given center and radius. (This function was used to set up a "picture" matrix of geometric shapes in a pattern-recognition algorithm.) The TRANS function transforms a matrix of numbers into a matrix of symbols, with the individual symbols used to reflect the value of the corresponding numeric matrix entry. The IVER function was presented by Dr Kenneth Iverson in the article "Understanding APL" (August 1977 BYTE, page 36). When given a right argument of seven or larger, it returns a vector containing all the prime numbers up to and including that number. (For example, IVER 11 returns the vector 2 3 5 7 11.)

Notes:

• All of the above tests are performed on either 10 by 10 matrices or 100-element vectors; in addition, the tests were carried out to minimize the amount of time outside the operation being timed.

• In some cases, a version of APL could not operate on a given size matrix. An asterisk denotes an estimated entry made by adjusting the time an operation took for a smaller matrix.

• CIRCLE, TRANS, and IVER (shown in listings 3 thru 5) are APL defined functions used to compare the persions of APL in a morking environment

versions of APL in a working environment.

• All numbers here are given to 2 significant digits.

• In the cases where a version of APL gives the user an APL defined function (a short program written in APL) to use when the operation is not in the machinecode version of APL, the defined function is used in the above timing tests. For example, none of the above

versions of APL incorporate matrix divide in their versions, but Softronics and Vanguard supply an APL defined function to do the same operation.

•NA means the function is not available in a given

version of APL.

• The Ramware APL80 was run on an unmodified Radio Shack TRS-80 Model I with one disk drive and 48 K bytes of memory. The TRS-80 runs at 1 MHz; all timing figures should be halved for users running modified TRS-80s at 2 MHz.

● The Softronics APL was run on a Cromemco Z2D with 56 K bytes of memory, running at 4 MHz.

• The Vanguard APL/DTC software was run on an APL/DTC computer with 80 K bytes of memory, running at 4 MHz. Users buying the Vanguard APL/V80 software should expect slightly decreased performance varying with the amount of memory in the system.

Text continued from page 196:

be devised. APL operators that normally do not appear on the keyboard have a 1-character substitution. For example, the character % replaces the APL division operator \div , and parentheses () replace the square brackets [] used in APL to denote subscripts. Other characters are represented by a shifted keyboard letter; for example, shift-q is used for the APL character \Box (a quad), and shift-i is used for the APL iota operator ι . On the TRS-80 video screen, these characters are displayed as their uppercase alphabetic equivalents (because an unmodified TRS-80 has no lowercase letters) with a little graphic dot just below and to the left of the uppercase let-

ter. This, plus one space on the left of the single letter substitution, makes this system more readable. (See photo 1 for the APL80 equivalent of the CIRCLE function of listing 3a).

Many other Level II-related features make Ramware APL80 a usable product and certainly the best buy dollar-for-dollar. Several other features that must be mentioned are sequential and random access of APL disk files and access to the real-time clock; other features are listed in table 3.

Vanguard APL/DTC Computer and Software

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Photo 1: The APL function CIRCLE as presented by Ramware APL80. In this version of APL for the TRS-80 Model I, nonstandard APL characters are replaced by either a 1-character substitution or by a single letter marked by a graphics dot below and to the left of the letter.

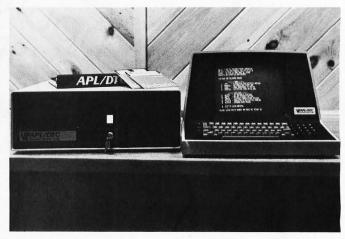


Photo 2: The Vanguard Systems Corporation APL/DTC. The system includes: the APL/DTC (desk-top) computer, on the left; its associated APL terminal, on the right; and, on top of the computer, documentation and two floppy disks of software—customized CP/M and Vanguard APL.

sion of APL, which was reviewed as a computer/software combination called APL/DTC. The computer and software have been optimized for each other, creating a version of APL that is slightly more powerful than its stand-alone software counterpart, APL/V80.

The APL/DTC system, which carries a label of the same name (see photo 2), is actually a Vector Graphics microcomputer with modifications made at Vanguard Systems Corp. (One modification results in the computer holding 80 K bytes of memory.) Its associated terminal, which displays all APL characters (as shown in photo 3) has an APL keyboard and is a Vector Graphics "Mindless Terminal" (a keyboard and video display that connects to a memory-mapped video board inside the computer proper). Its associated video board has a PROM (programmable read-only memory device) that generates the APL character set. The APL/DTC computer runs CP/M as customized by Lifeboat Associates and Vanguard. The

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Tape load with labeling ... tape dump with labeling ... examine/change contents of memory ... insert data warm start . . . examine and change all registers

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single step with register display at each break point go to execution address. Level "A" in this version makes a perfect controller for industrial applications,

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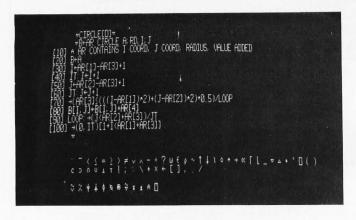
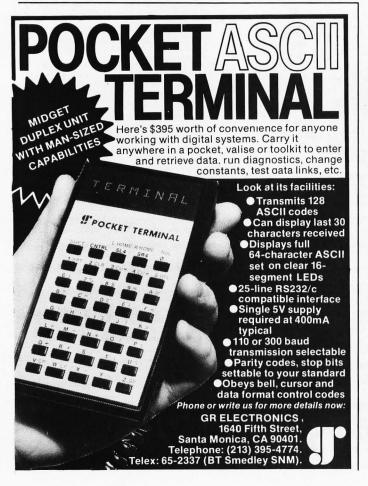


Photo 3: Listing of the APL function CIRCLE on the APL/DTC terminal screen and, below, a listing of special APL characters as they appear on the APL/DTC terminal. The last row is composed of characters that are created using an overstrike.

price tag of \$7995 is rather steep for an APL machine, but a large body of CP/M software, including other computer languages, is available for the machine, somewhat mitigating the expense.

The language itself, called APL/V80 and available for \$500 in a variety of formats, is the undisputed winner in every category except cost and documentation. The fact that it is more expensive is reasonable; after all, it does offer a faster APL that implements more operators. However, its weakness in the documentation, though slight, is disturbing.



Because its documentation is not of the same caliber as the rest of the package, the software must stand on its own merits. (Fortunately, it does.) The documentation is terse, sometimes cryptic. Much of the language is defined in charts that give only the name of the operation being performed. Only one or two examples are given for each operator, far too few to be able to generalize. Comparing the Vanguard documentation to the Softronics documentation (which takes up to a half page to describe an operator and includes examples), I can summarize by saying that the Softronics documentation is much more "friendly" and much more useful as both a tutorial and a reference.

On the positive side, APL/V80 includes information on customizing the software and on building and using auxiliary processors (software) that allow the language to interface to custom external devices through Z80 I/O ports. In addition, Vanguard provides a set of APL defined functions (in both printed and disk file form) that implements almost all of the functions not in its APL. Data files can be accessed either sequentially or randomly through a mechanism called shared variables; this method is used by the IBM 5100 computer and other computers to provide an APL-like mechanism for interacting with disk files.

Vanguard has solved the problem of using its APL/V80 on an unmodified ASCII computer. According to Dr John Howland of Vanguard Systems Corporation, a defined function is included in the APL/V80 package that, when executed, allows the user to edit and list APL functions using mnemonic substitutes of any length for the APL characters that are not on a regular ASCII keyboard. Although I have not seen this system at work, it sounds like a viable solution.

Several notes are in order in relation to tables 1 and 4. The information in these tables is based on the APL software supplied with the APL/DTC computer, not the APL/V80 software. Again, according to Dr Howland, the APL/V80 software should run at the same speed as the software running on the APL/DTC computer (assuming that the Z80 board of the host computer runs at 4 MHz, the system clock frequency of the APL/DTC). This means that the timing figures of table 1 are valid for the APL/V80. In addition, the software features in table 4, listed as available on the APL/DTC, are also in the APL/V80 software, with the exception of the inner product function (available as a defined function in APL/V80). The APL/DTC allows an APL workspace of 34 K bytes, while the APL/V80 software allows a workspace of about 27 K bytes when running on a 64 K-byte CP/M system. The additional memory space used by the APL/DTC software is devoted to the implementation of hardware-related features (such as access to the real-time clock and a machine-related security function).

Conclusions

Versions of APL *are* available to fit every budget. The Ramware APL80 is a usable version of APL for the TRS-80, and it is quite a bargain at \$39.95. Softronics APL, although it does have some serious limitations, is in a medium price range at \$350. Vanguard APL/V80, at \$500, is the fullest and fastest APL. Your needs and the amount of money you can spend will determine which version is best for you. ■

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News and Speculation About Personal Computing

Conducted by Sol Libes

Sony Enters Word-Processing Arena: The Sony Corporation is a real innovator. First, it decided to enter the word-processing market. Then it introduced a new concept in word processing that's surely a winner. Called the Typecorder, it consists of a small keyboard/ microcassette unit Sabout the size of two issues of BYTE. ... GW] that has a microcomputer and 1-line LCD display; it costs \$1400. Small enough to fit into your briefcase, it permits you to create text, edit it, and store it on tape. The tape can be run off on a companion printer, available for \$800, or through a word-processor system due later this year. You can transmit the text over telephone lines via an optional acoustic-coupler modem, or you can process the text through a non-Sony system. Typecorder lets you mix audio and digital information on cassette, so you might devise some interesting computer-assisted software.

I have no doubt that Sony's concept, features, and low price will be popular and will lead to applications beyond word processing.

Close Look At The IBM Displaywriter: IBM is now delivering its new lowcost Displaywriter word-processing system; it's only \$1000 more than the Radio Shack TRS-80 Model II, and it's really a general-purpose microcomputer that uses the Intel 8088 microprocessor.

IBM rents word-processing software for \$50 per month, which sounds rather steep; however, consider the TRS-80 owner who uses WordStar. WordStar costs \$500, plus another \$150 for the CP/M operating system.

Further, MicroPro International issues WordStar updates about four times a vear at \$25 to \$40 apiece. Hence, WordStar can cost a user about \$850 for the first year of operation.

My point is that the price difference between a wordprocessing system using an IBM (or Wang, Lanier, etc) and a Radio Shack system is really not that great. Add to this IBM's terrific service and its promises of extended I/O. communications, and applications packages for the Displaywriter, and you'll see that IBM is competing aggressively in the microcomputer marketplace.

W ord-Processing Prices Dropping: Wordprocessing-system prices are dropping. Following on the heels of IBM's new low-cost word-processing system, Wang Laboratories has introduced a new stand-alone system for \$7500, with discounts offered on multiple units. Lanier Business Systems is expected to introduce an inexpensive system. A B Dick is planning a \$7500 system that includes software (the others do not), and is drawing up plans for a local-network system that shares a printer, which will further reduce costs.

Computer Hobbylsts Gather For Huge Flea Market: On Saturday and Sunday, April 25th and 26th, several thousand computer hobbyists will flock to Trenton State College, Trenton, New Jersey, for the Trenton Computer Festival, the world's largest personal-computer-equipment flea market. This annual outdoor event is now in its sixth year. A multitude of swap and seller tables covering more than 5 acres of real estate feature everything from complete computer systems to tiny electronic parts. There will be speakers, user-group meetings, an indoor exhibition area, and a banquet on Saturday night.

The Festival is sponsored by the Amateur Computer Group of New Jersey, the Philadelphia Area Computer Society, and the Trenton State Computer Society. The funds raised help support these nonprofit organizations and their activities. For information, call (609) 771-2487, or write to TCF-81, Trenton State College, Trenton NI

redit Cards With Intelligence? The Battelle Memorial Institute is studying the feasibility of a credit card with a built-in microprocessor. Such a card has already been developed in Europe and will soon be tested. It is expected that intelligent credit cards will provide added security without requiring large computer networks.

ome-Information Market Takes Shape: Several tests are underway to determine the best way to capture the lucrative homeinformation market. In the meantime, there's a battle brewing for control of the market, and the major contestants are the telephone companies, principally AT&T (American Telephone and Telegraph) and the cable-television companies.

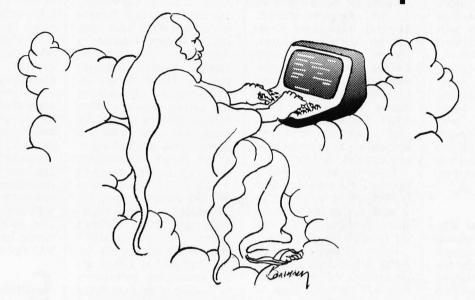
By 1983, AT&T is expected to launch its home-information systems. A user will probably have to buy a special video-display terminal, about \$250, plus pay a monthly service fee in the \$4 to \$8 range.

The cable-television companies plan to provide the same two-way services. Companies such as Westinghouse, General Electric, and American Express are snatching up cable-television outfits. Several cabletelevision home-information systems are already in operation. However, the real battle is at least two years away when AT&T actually enters the market.

he Terminal You May Have Been Walting For: Hewlett-Packard has introduced a super-intelligent terminal, called the Model 2626A. It displays 119 lines with 160 characters per line; moreover, the display can be divided into four windows. There are two independent I/O ports, so that vou can simultaneously communicate through separate windows with two different computers. There are user-programmable keys, and the bell has fifteen pitches, sixteen intensities, and two volumes-which means that you can play decent-sounding music on it.

Vicrosoft And DEC Join Forces: Microsoft's first software product was a 4 K-byte BASIC interpreter, which used keywords similar to DEC's (Digital Equipment Corporation's) BASIC-Plus. It launched Microsoft on the road to success with expanded BASICs and other language packages. DEC has now adopted Microsoft BASIC for its GIGI (general imaging generator and interpreter) color-graphics system. Microsoft's BASIC is contained in ROM (readonly memory) in a microprocessor-based unit. GIGI is used with the PDP-11 and VAX-11 systems.

Whether the job is building a home or a world MILESTONE helps...



With today's concerns about increasing costs and declining productivity it is true more than ever that any project worth doing deserves careful planning. Whether your're planning a construction project or the opening of a new retail store, you must carefully schedulue your manpower, dollars and time in order to maximize productivity.

MILESTONE is a critical-path-network-analysis program. It runs on a desktop microcomputer, is inexpensive and simple enough for anyone to use.

MILESTONE's design is a product of many years of experience in the "real world" of small-project management. In such an enivornment the primary purpose of planning is to help the project leader clarify the task at hand and to help him communicate his ideas to his subordinates and superiors. For these two reasons the designers of MILESTONE stressed it's interactivity and comprehensive reporting.

Most of the design effort was put into eliminating unnecessary or redundant operator input and to checking all entries for validity. By organizing the project data for you, you can interactively modify your project plan leaving **MILESTONE** to perform the tedious calculations and to display the results.

Internally, **MILESTONE** treats your project as a series of activities. Each activity has a name, duration, capitol cost, mix of manpower, and an associated list of other activities that must be completed first. The list of associated activities (or prerequisites) provides a thread that **MILESTONE** uses to link all the jobs together into an overall project schedule. Every time you add a new activity or make a change to an existing one, the entire schedule is recomputed and the results are immediately redisplayed on the screen.

For **MILESTONE** a project is simply any task made up of steps that must be performed in sequence. After dividing a project into it's composite steps, **MILESTONE** can help you plan, schedule and control the project.

Specifically here are some of the things you can do,

- Find out which activities are time critical and can't be delayed
- Discover which activities have slack time and can be delayed without delaying the entire project
- Prepare a detailed cost estimate based upon a summation of each activity's individual equipment and manpower expenses
- Change an activity and instantly see the impact on the overall project schedule
- Investigate tradeoffs between manpower, dollars, and time
- Keep track of your project's progress by periodically updating the schedule to reflect changes in the plan and completed activities

MILESTONE requires 54K RAM and CP/M, Apple Pascal, or UCSD Pascal. CP/M versions need no support language. All Apple II versions require 24 x 80 video card. Formats: 8" single denisty IBM soft-sectored, NorthStar DD, Micropolis Mod II, Superbrain 3.0, Apple II. Price is \$295. Manual alone - \$30. Add \$7.00 for shipping.



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Diagnostic Disk Troubleshoots Your Disk Drive: Dysan Corporation will introduce a floppy disk that checks disk-drive operation. It contains software and geometric patterns that test radial positioning, linearity, hysteresis, eccentricity, index timing, skew, relative head positioning, azimuth, drive rpm (revolutions per minute), head load, access time, and head/ media compliance. The first model to be introduced will be a \$40 IBM 3740-compatible 8-inch disk.

V ord-Processor Dictionary introduced: IBM's new Displaywriter word-processor system features an optional dictionarysoftware package that checks the spelling of up to 70,000 words. Similar packages will soon be available for other systems. The first is Microspell, to be distributed by Lifeboat Associates. It checks the spelling of any ASCII-text file stored on disk under CP/M. Thus, the program can be used with files created by WordStar, Word-Master, Magic Wand, and other word-processing packages.

BM Status Report: Many critics want you to believe that IBM's dominance in the data-processing market is eroding rapidly. Don't believe it, because more than a third of the \$60 billion 1980 computer market was IBM's. In all industry, IBM's \$23 billion in sales ranked eighth, and its \$3 billion in total profits was third. By contrast, the second largest computer maker, Burroughs, had \$2.83 billion sales and \$305.5 million in

IBM is not always the technological leader. Rather, it has used marketing clout to establish dominance in any market it enters. For example, IBM sells 70% of the large mainframe computers in the USA.

However, during the last few years, DEC (Digital Equipment Corporation), Data General, Wang Laboratories, and Amdahl have grabbed an increasing share of the computer market. Several lapanese companies, such as Fujitsu, Hitachi, and NEC (Nippon Electric Company), are also moving in on IBM's territory. On the horizon, IBM faces strong competition from AT&T, Xerox, and Exxon, as they move into local and interoffice data-communication network markets.

These factors have had a serious impact on the value of IBM's stock. In the 1960 s, it sold for as much as 66 times earnings; it now sells for 15 to 20 times earnings.

IBM's strategy for the 1980s is based on a coming generation of mainframes that will set new levels in price versus performance and emphasize telecommunication networks. In addition, IBM has opened retail stores and is entering several new markets via joint ventures, such as a videodisk project and satellite communications. However, it is likely that these projects will be a minor part in the whole IBM strategy for the 80s. Although IBM will become more involved in data networking, its focus will continue to be large central data-processing operations.

New 8-Inch Winchester Has 136 Megabytes: Ontrax Corporation has unveiled the largest capacity 8-inch Winchestertype disk drive to date. It stores 136 megabytes on five platters using sixteen read/ write heads. With a controller, the drive sells for \$5000 in quantity. That's 0.004 cents per byte, compared to about 0.2 cents per byte for a typical single-density floppy-disk drive.

andom News Bits: Computerland, High Technology, and The Computer Store plan to stock at least one Japanese-made personal computer. Japanese sup-

pliers currently being considered are NEC, Casio, Canon, Sharp, and Panasonic. ... Tandy Corporation and the Professional Farmers of America (PFA) have introduced Instant Update, a data-base service that uses TRS-80 videotext terminals (actually TRS-80 Model II). Via telephone connections, the service provides information affecting commodity prices and crop yields and gives access to Washington Watch News. Commodity prices are updated every 10 minutes. The service costs \$95 per month. ... Sony has introduced a 31/2-inch microfloppy-disk drive. (Editor's note: See this month's editorial.) It is currently being marketed to OEMs and systems houses; its capacity is reputed to be over 800 K bytes (unformatted) per disk. ...Two teenagers have been charged with masterminding a scheme that shut down DePaul University's computer during enrollment week. The shutdown cost DePaul \$22,252 in computer time, repairs, and manpower. The teenagers said they did it to disprove the school's claim that it couldn't be done. ...Intel Corporation announced its figures on net income and revenues for the year that ended December 31, 1980. Net income was \$96.7 million, up 24% from the previous year, and revenues were \$855 million, up 29% from 1979. Most of the growth occurred in the first half of the year....

Kandom Rumors: Informed sources say that Tandy will lower the price of its Videotext terminal to compete with AT&T's projected home-information terminal. ...Apple Computer is developing a new microcomputer using the 16-bit Motorola 68000 microprocessor. ...At least one software-development house has leaked that it is seriously negotiating with Apple on a disk operating system for a machine called the Apple IV. ...Look for a lower-priced version of Hewlett-Packard's HP-85

desk-top computer-maybe less than \$2000-to be called the HP-83. It lacks some of the HP-85's features, but it has a plug-in disk-drive option. ... Exxon's Kylex division is developing a 40-row by 80-character LCD (liquiddisplay) crystal computer-display terminals. ...Sony might be developing a personal-computer system for this year's market. Sony may include an interface for its new Typecorder wordprocessor terminal. ... Digital Equipment Corporation is developing a new line of personal-computer products with extensive software support, including an operating system based on RT-11 with VAX-compatible BASIC....

OBOL For The 8086 Announced: The software picture for 8086-based 16-bit microcomputer systems keeps improving. Seattle Computer Products has announced an 8086 version of Microsoft BASIC. Now Microsoft has COBOL-86, which runs under the CP/M-86 operating system.

The projected execution time of these packages is three times as fast as the 8080/Z80 versions. As a result of the 8086's multitasking capabilities, the packages will be better suited for multiple-user systems than the 8-bit versions.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a stamped, self-addressed envelope.

Sol Libes POB 1992 Mountainside NJ 07092

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SuperSoft's Gallery of CP/M Master

SUPER-M-LIST: A complete, easy to use mailing list program package. Allows for two names, two addresses, city, state, zip and a three digit code field for added flexibility. Super-M-List can sort on any field and produce mailing labels direct to printer or disk file for later printing or use by other programs. Super-M-List is the perfect companion to TFS. Handles 1981 Zip Codes! Requires: 48K CP/M

Supplied with complete user manual: \$75.00 manual alone: \$10.00

TFS-Text Formatting System: An extremely powerful formatter. More than 50 commands. Supports all major features including:

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TFS lets you make multiple copies of any text. For example: Personalized form letters complete with name, address & other insertions from a disk file. Text is not limited to the size of RAM making TFS perfect for reports or any big job. Text is entered using CP/M standard editor or most any CP/M compatible editor. Requires: 24K CP/M

Supplied with extensive user manual: \$85.00 manual alone: \$20.00 Source to TFS in 8080 assembler (can be assembled using standard CP/M assembler) plus user manual: \$250.00.

TEXT PROCESSING

DIAGNOSTICS I: Easily the most comprehensive set of CP/M compatible system check-out programs ever assembled. Tests

 CPU (8080/8085/Z80) • Terminal • Disk To our knowledge the CPU test is the first of its kind anywhere. Diagnostics I can help you find problems before they become serious. A good set of diagnostic routines are a must in any program library. Minimal requirements: 32K CP/M. Supplied with complete user manual: \$75.00 Manual alone: \$15.00

DIAGNOSTICS II: Includes all of Diagnostics I, plus:

- Every test is "submit"-able
- A complete Spinwriter/Diablo/Qume test has been added (Serial Interface only)
- Output may be logged to disk
- Expanded memory test Expanded terminal test
- Expanded disk test

Diagnostics II provides the next level in system maintenance. Requires: 32K CP/M

dede

Price: \$100.00 Manual only: \$15.00

SYSTEM MAINTENANCE

UTILITIES I: A collection of programs that you will find useful and maybe even necessary in your daily work (we did!). Includes: GREP: Searches files for a specified string

SORT: In core sort of variable length records CMP: Compare two files for equality PRINT: Formatted listings to printer

Lists files to CRT a page at a time PG: ... plus more ...

Requires: 24K CP/M

Supplied with manual on discette: \$60.00

UTILITIES II: Many new programs not available elsewhere. Includes these 'file" utilities:

DIFF: Source comparitor

PR: Powerful multicolumn output formatter

Concatenate files

Substitute strings in files

. . plus more . Requires: 24K CP/M \$60.00

Supplied with manual on discette

UTILITIES

ANALIZA: An amazingly accurate simulation of a session with a psychiatrist. Better than the famous "ELIZA" program. Enlightening as well as fun. An excellent example of Artificial Intelligence. Requires: 48K CP/M, CBASIC2 Cost: \$35.00

ENTERTAINMENT |

Z8000 CROSS ASSEMBLER: Supports: full Z8000 syntax, segmented and unsegmented mode, full 32-bit arithmetic, hex output, listing output, 'downloader' Requires: 56K CP/M \$500.00 1 year maintenance \$300.00 manual alone

28000 too! ::::::::

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Notice the second section to be second

On line "Help" system provided with every program package.

SuperSoft First in Software Technology

'TINY' PASCAL II: We still call it 'Tiny' but it's bigger and better than ever! This is the famous Chung-Yuen 'Tiny' Pascal with more features added. Features include:

recursive procedures/functions • integer arithmetic • CASE • 1 dimensional arrays sequential disk I/O FOR (loop)

IF THEN FLSE . WHILE . PEAK & POKE READ & WRITE . REPEAT LINTIL • more

'Tiny' Pascal is fast. Programs execute up to ten times faster than similar BASIC programs. SOURCE TOO! We still distribute source, in 'Tiny' Pascal, on each discette sold. You can even recompile the compiler, add features or just gain insight into compiler construction.

equires: 36K CP/M. Supplied with complete user manual and source on discette: \$85.00. Manual alone: \$10.00

STACKWORK'S FORTH: A full, extended Forth interpreter/compiler produces COMPACT, ROMABLE code. As fast as compiled FORTRAN, as easy to use as interactive BASIC

SELF COMPILING: Includes every line of source code necessary to recompile itself

EXTENSIBLE: Add functions at will. Z80 or 8080 ASSEMBLER included. Single license, OEM licensing available.

Please specify CPU type: Z80 or 8080 Supplied with extensive user manual and tutorial: \$175.00

Documentation alone: \$25.00

SSS FORTRAN: The SSS FORTRAN compiler is fast, efficient, and complete (full 1966 ANSI standard with extensions). The RATFOR compiler compiles into FORTRAN allowing the user to write structured code while retaining the benefits of FORTRAN. The FORTRAN supports many advanced features not found in less complete implementations, including: complex arithmetic. character variables, and functions. Complete sequencial and random disk I/O are supported. SSS FORTRAN will compile up to 600 lines per minute! Recursive subroutines with static variables are supported. ROMable ".COM" files may be generated. SSS RATFOR allows the use of contemporary loop control and structured programming techniques. SSS RATFOR is similar to FORTRAN '77 in that it supports such things as:

 REPEAT...UNTIL • WHILE . IF. THEN ELSE

SSS RATFOR is supplied with source code in FORTRAN and RATFOR. System Requirements & Prices

SSS FORTRAN requires a 32K CP/M system. SSS FORTRAN with RATFOR: \$325.00

SS FORTRAN alone: \$250.00 RATFOR alone: \$100.00

(Sold only with valid SSS FORTRAN license)

PROGRAMMING LANGUAGES

TERM: A complete intercommunications package for linking your computer to other computers. Link either to other CP/M computers or to large timesharing systems. TERM is comparable to other systems but costs less, delivers more and source is provided on discette! With TERM you can send and receive ASCII and Hex files (COM too, with included convertion program) with any other real time communication between users on separate systems as well as acting as timesharing terminal.

Engage/disengage printer · error checking and auto retry terminal mode for timesharing between systems

conversational mode · send files

· receive files Requires: 32K CP/M

Supplied with user manual and 8080 source code: \$150.00

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ENCODE/DECODE: A complete software security system for CP/M. Encode/Decode is a sophisticated coding program package which transforms data stored on disk into coded text which is completely unrecognizable. Encode/Decode supports multiple security levels and passwords. A user defined combination (One billion possible) is used to code and

Encode/Decode is available in two versions:

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CP/M Formats: 8" soft sectored, 5" Northstar, 5" Micropolis Mod II, Vector MZ, Superbrain DD/QD



All Orders and General Information: SUPERSOFT ASSOCIATES P.O. BOX 1628 CHAMPAIGN, IL 61820 (217) 359-2112 Technical Hot Line: (217) 359-2691 (answered only when technician is available)

CP/M REGISTERED TRADEMARK DIGITAL RESEARCH

SuperSoft's DIAGNOSTICS I&II for CP/M

Since the beginning, programs have been written to verify the correctness of computer systems. This task has usually fallen on the manufacturers of computer equipment. However in the case of microcomputers, the manufacturers have been reluctant to supply such programs along with their hardware. First, because they often are not the ones called on to fix that hardware, and second, because the low cost of such systems often does not allow for such a large programming effort. The tremendous number of CP/M systems have made it possible for us to offer both **DIAGNOSTICS**—I & II at an affordable price, since we do not have to deal with a myriad number of console devices and disk systems; we simply use the standardized system calls.

Both packages perform tests on the five critical areas of your computer system:

 Memory • CPU Printer

Terminal

· Disk drive

DIAGNOSTICS-I provides an excellent level of testing. DIAGNOSTICS-II is simply the finest set of system maintenance routines ever written for microcomputers. DIAGNOSTICS-II includes all of DIAGNOSTICS-I, but goes much further in providing the user with even more checks, tests, and reports

DIAGNOSTICS—I Features

The MEMORY TEST allows every byte of user memory to be tested. Both a quick test as well as a 'walking bit' test are included. Error reports summarize errors by bit as well as address.

The CPU TEST interprets a program that is designed to execute all single instruction sequences and many multiple instruction sequences. After each instruction sequence, the program tests all of the CPU registers to see that the proper registers changed correctly, and only those registers changed. This will detect, for instance, if storing into the A register affects the B register. The CPU test will automatically recognize the type of CPU you have. To the best of our knowledge, nothing as powerful as the CPU test is available anywhere else.

The **PRINTER TEST** prints a one line pattern, then rotates the pattern one character and prints again. This barber pole scheme is simple, yet elegant, since it checks that every printable character can be printed in every printer column, and does so in a manner that makes any error obvious at a glance.

The TERMINAL TEST prints a 'barber pole' and then exercises cursor positioning, foreground, background, eraseall, erase-to-end-of-line, erase-foreground, and erase-background. If some of these features are not available on your terminal, they can be skipped. The test can be used with any terminal; many standard types are supplied pre-patched. any other can be patched by the user.

The DISK TEST writes a unique pattern in each sector, and then does a pseudo-random seek/read test within the file area.

DIAGNOSTICS-II Features

Every test is "submit"-able. In fact, a sample submit file is provided with each disk. This means that the user can run a series of tests without operator interaction. To further decrease the need for the user to "baby sit" the tests, the output of tests may be logged to disk for later review. This makes overnight testing very easy yet informative.

We started with **DIAGNOSTICS**—I and added all the features that users wanted as well as some of our own. Below is a description of some of the enhancements.

MEMORY TEST:

- Default to size of CP/M TPA
- Bank select (a necessity for more than 64k)
- Memory map of system displayed
 Memory speed test
- · Burn in test

PRINTER TEST:

 Spinwriter, Diablo, Qume test which checks all head and carriage motions as well as ASCII printing features. (This is a very thorough test!)

DISK TEST:

- · Writes a unique pattern to each sector on disk, verifying as it runs.
- User defined seek patterns allowed. (This is great for drive allignment and testing!)
- · Tests user specific user defined sectors.

The TERMINAL TEST is the same as for DIAGNOSTICS—I except that it is "submit"-able.

The CPU TEST is the same except that it is "submit"-able and output may be logged to disk.

Also, a QUICK TEST has been added which will check the memory, disk drives, and CPU in your system in less than four minutes! The test is, of course, not as thorough as the ones described above, but provides a measure of confidence. It is particularly useful if used every time the system is powered up.

DIAGNOSTICS I: \$75.00 DIAGNOSTICS II: \$100.00 (manual only): \$15.00 Both require 32K CP/M

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CP/M Formats: 8" soft sectored, 5" Northstar, 5" Micropolis Mod II, Vector MZ, Superbrain DD/QD

An Introduction to Data Compression

Harold Corbin 11704 Ibsen Dr Rockville MD 20852

Even though the cost of data storage continues to decrease fairly rapidly, there are still a number of situations where it is desirable to squeeze more data into a physical storage device. Often the typical microcomputer has limited memory, small disks, or slow cassettes. With any of these storage limitations, data compression may offer a method of using the existing device to store larger quantities of data or to provide improved access time to the data. The use of data compression can also provide significant improvement in the transmission of data over communication networks since there are fewer bits to send in order to convey the information.

ASCII code does not consider that the frequency of the characters in the file is not uniform.

The basic idea in data compression is to use more efficient codes to represent the information in a file or to remove redundant and unnecessary information from the file. With data compression in effect, the system stores or sends only the minimum data necessary to convey the original information.

In a typical file, the individual characters are represented by fixed-length codes such as ASCII (American Standard Code for Information Interchange). This representation does not consider that the frequency of occurrence of the characters in the file is not uniform. In typical English text, E is the most common letter and Z is the least frequently used letter. Table 1 presents a frequency analysis for letters in English text. Using a code such as ASCII for storing or transmitting text means that

the same number of bits is used for the most frequently occurring letter as well as for the least frequently occurring letter. This method of encoding data uses more bits to represent the information in the file than is necessary. In this article, I will illustrate ways to store data more efficiently.

Encoding the data in a more efficient form is called data compression. There are a variety of methods that have been used to compress data, but all of them attempt to reduce the redundancy of the original data. Most large data-processing systems provide some form of file compression, since storage costs money. Also, it is often less expensive to pay for the computer time to compress and expand the data than to pay for mass storage. The user of a large system usually has PACK and UNPACK commands available to allow compression and expansion of his files.

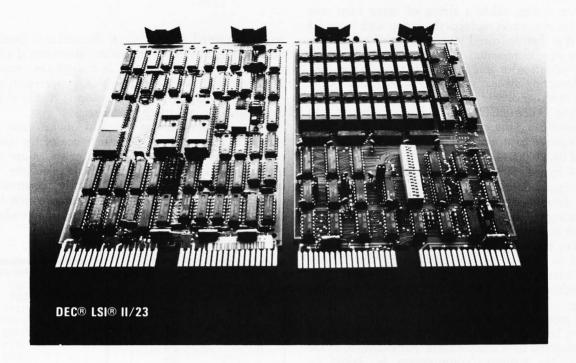
Typical data-processing systems use some form of zero or space suppression to do their data compression. This method is easy to implement and not very expensive to run, and produces fairly good compression for many types of data. The efficiency of this compression method is dependent upon how many spaces or zeros occur in the file. Typically, a source file of assembly-language statements is a good candidate for data compression. Fifteen to twenty percent compression of an assembly-language source file is not uncommon.

Data-Compression Methods

A space-compression capability can be implemented in several ways. Two common ones are *bit mapping* and *recurrence coding*. In the bit-mapping scheme, a bit map exists that is long enough to match one bit of the bit map to each byte of data in the original file. In the map, a 0 is stored for each byte in the data that is a space, and a 1 is

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stored in the map for each corresponding byte in the data that is not a space. This way, the data can be stored with all spaces removed and still be easily reconstructed by first examining the bit map to determine where the expanded file needs to have a space or spaces inserted as the next data byte.

Recurrence coding takes a string of more than two repetitive characters and replaces the string with a special character. It is then followed by the count of how many occurrences of the repeated character are being compressed. A variation of this method is used in the IBM VM/370 Operating System with the PACK option of the COPYFILE command.

If the string "ABbbbbCD" (where b is a space) were to be compressed using the bit-mapping technique, 5 bytes would be required to store the data and the bit map. The map would be 11000011 (1 byte) and the data would be "ABCD" (4 bytes). Since only 5 bytes are required to store the original data in compressed form instead of 8 bytes, the data is compressed to 62.5% of its original length. Storing the same string using recurrence coding would result in a compressed string of "AB*4CD", where "*4" replaces the four spaces. In this case, the data is compressed to 75% of its original length. You can see that the efficiency of a given method is dependent upon both the method itself and the characteristics of the data's redundancy.

Another method of compression is known as *pattern* substitution. In this method, each occurrence of a specific pattern is replaced by a unique code. For example, in the above text, the pattern "compression is" could be replaced by a single 8-bit byte — say, 11111001. This would compress each occurrence of the 14 ASCII bytes in the pattern to a single byte. Obviously, if there were more than 256 patterns, the code pattern would have to be bigger than 8 bits to maintain uniqueness.

Variations of this method could mix the ASCII code and the pattern code. One scheme would place a unique code — for example, the ASCII ESC (escape) character — ahead of the pattern code. When the PACK routine encounters the ESC character, the next byte is replaced with its equivalent pattern.

Another scheme that would permit ASCII and pattern codes to be mixed would tag the pattern codes by setting the high-order bit to 1. This would restrict the ASCII to 128 codes and the patterns to 128 codes.

The efficiency of the pattern-substitution compression methods can be very useful if the pattern is long and its number of recurrences is high. Some compression systems based upon this method have sophisticated programs that search the data for patterns and assign codes to the patterns in an optimal manner.

Some compression methods are data-value dependent. One of these methods is *difference compression*. For example, if succeeding records had a field with the following values:

1,732,517 1,732,217 1,732,200 1,732,190

either the difference between succeeding fields or the difference from a base value could be stored as the compressed data. In the first case, the values

would be stored. Obviously, if the field is of fixed length, nothing is gained by compression. However, if a variable field-length capability exists in the system, some space savings can be achieved with this compression method. Again, the amount of compression is highly dependent upon the data and its characteristics.

Another compression method makes use of the statistical properties of the occurrence of the data to be compressed. In this method, shorter codes are used for the more frequently occurring data elements. Longer codes are used for less frequently occurring data elements. One code used in data compression that optimizes the encoding values is the Huffman code. There

Letter	Frequency (%)
Е	13.0
E T A O N	10.5
Α	8.1
0	7.9
N	7.1
R	6.8
1	6.3
S	6.1
Н	5.2
D	3.8
L	3.4
F	2.9
С	2.7
M	2.5
U	2.4
G	2.0
Y	1.9
P.	1.9
W	1.5
В	1.4 0.9
V	0.4
\$	0.4
- S H D L F C M U G Y P & B > K X J Q Z	0.13
ŏ	0.13
7	0.07
	0.07

Table 1: Relative frequency of the alphabet in the English language. In most character codes (including the common 7-bit ASCII), every letter is represented by the same number of bits. But one method of data compression assigns shorter codes to the frequently used letters (ie: E, T, and A) and longer codes to seldom used letters (ie: Q and Z). A message stored in this kind of code should be significantly shorter in bits than the same message stored in ASCII.

Letter	Huffman Code
E	100
T	001
À	1111
A O	1110
N	1100
R	1011
i	1010
S	0110
Н	0101
D	11011
L	01111
L F C	01001
С	01000
М	00011
U G	00010
G	00001
Y	00000
P	110101
W	011101
В	011100
V	1101001
K	110100011
X	110100001
J	110100000
J Q Z	1101000101
Z	1101000100

Table 2: A Huffman code. There are many Huffman codes; this is the one that is used in figure 2 and listings 1 thru 4. Note that the shorter codes are used for frequently occurring letters, and that no code is a beginning substring of a longer code.

The average number of digits used to represent a letter can be reduced toward the entropy limit H if the Huffman technique is used to encode blocks of letters rather than individual ones.

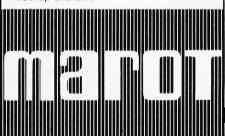
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Name Company Address City/State/Zip are actually many Huffman codes, but they are similar in structure.

Before explaining how to construct a Huffman code, I will describe a typical Huffman code and how it works. The code that is used in the two compression programs in this article is given in table 2.

To compress the word "compression", the appropriate

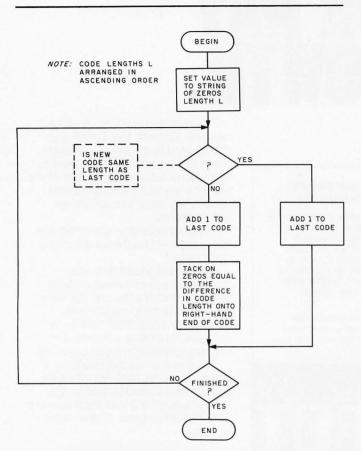


Figure 1: Flowchart for assignment of Huffman codes. This algorithm will produce a series of codes (Huffman codes) with the following two characteristics: the length of the code (in bits) is inversely proportional to the relative frequency of the symbol being encoded; and no code is a beginning substring of the Huffman code of another symbol. Together, these properties define a code with a unique decoding that uses the smallest number of bits to encode an average message.

binary code is assigned to each letter, which produces the binary string:

A quick count shows that 47 bits were required to encode the word "compression" with Huffman coding as compared to the 88 bits required with ASCII code. This gives a compressed text that is 53.4% of its original length. This level of compression is not too surprising since it is well known that the English language is highly redundant.

Of course the above example is a very short one. A larger piece of data should be used to find a more exact value of the amount of compression that can be expected from using Huffman coding. The actual efficiency can also be determined mathematically, but an explanation of that method is beyond the scope of this article. Using the program code described above with English text, approximately 4.18 bits would be required for each letter. Compared to 8-bit ASCII code, the compressed text is compressed to 52.2% of its original length.

Earlier in this article I mentioned that Huffman codes are optimized based upon the probability of the occurrence (ie: frequency) of the data element being encoded. In the program-code table (table 2), the more frequently occurring letters have the shorter codes, (eg: an E is coded with 3 bits). The number of bits, b, needed to encode a letter can be determined by the following formula:

$$b = f(-\log_2 p)$$

where p is the probability of occurrence of the letter, and f(x) is the closest integer greater than or equal to x.

From table 1, the probability of occurrence of an E in English text is 0.13; since $-\log_2 0.13 = 2.94$, the integer length is 3. If you were to continue to compute the code lengths from the probabilities in table 1, the lengths would differ from the code lengths used in the programs. This is because the program code lengths were determined from text that differs slightly in frequency from the text used to prepare table 1.

There are several ways the actual codes can be constructed. One method is shown in figure 1. To use the algorithm in figure 1, the letters must be arranged by



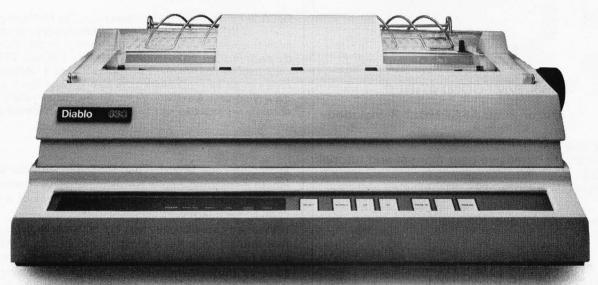
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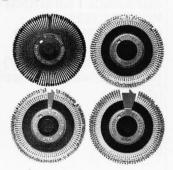
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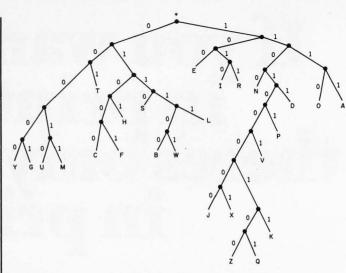


Figure 2: Binary tree for a Huffman code. The Huffman code for a letter is defined as the sequence of binary digits encountered when tracing the path from the root node, *, to the letter. Thus, the code for G is 00001, and the code for E is 100. This is the code used in the programs of listings 1 thru 4. Although this code cannot be produced by the algorithm of figure 1, it is a valid Huffman code (there are many) that can be validly used to illustrate the structure and implementation of Huffman codes in general.

ascending code length. Then the letter with the shortest length is assigned a code consisting of all 0s. Execution of the algorithm will result in the assignment of a unique code to each letter.

With any set of codes that are constructed, it is important that no code has a shorter code as part of its beginning. For example, if E is 100, then 10010 cannot be the code for another letter. This is because in scanning the bit stream from left to right, the decoding algorithm would think that 10010 is E (100) followed by 10 and not the different letter that was intended.

Regardless of the method used to construct the codes, the full set of binary Huffman codes can be represented as a binary tree. Figure 2 shows the binary tree that is equivalent to the Huffman code used in the programs of listings 1 thru 4. (These codes were not produced by the algorithm of figure 1.) This code structure allows the code to be uniquely decoded by simply starting at the top of the tree and walking down the tree, taking each branch that corresponds to the bit value, 1 or 0, as the coded data stream is scanned from left to right. This is the way the expansion program recreates the original data.

It is possible to combine various compression methods to increase the storage efficiency even more than when working with single letters. For example, Huffman codes could be assigned to patterns. Instead of working with the frequency of letters, you would use the frequency of the patterns. Thus, the pattern "code" might be represented by 010 and the pattern "data compression" might be represented by 10110. Obviously, a lot of compression could be achieved, particularly if single-letter and pattern methods are combined and certain patterns have a high frequency of occurrence.

Sample Programs

Two versions of both the compression and the expan-

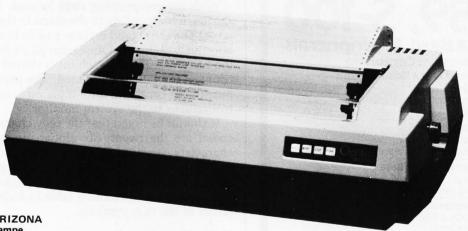
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sion programs have been prepared to demonstrate two different uses of data compression. The compression program, COMP1, demonstrates the basic concept. (See listing 1.) Characters are entered from the keyboard and the output of the program is a serial bit stream that could be sent to a cassette for storage of the compressed data. Such a scheme could result in reduced writing time and faster access to the data. The tradeoff involved is the usual one in many data-processing situations; namely, storage space saved versus computer time used to encode and decode the data.

The amount of compression is highly dependent upon the data and its characteristics.

Since COMP1 is for demonstration purposes only, the program is simplified somewhat by storing the serial data 1 bit per byte of memory. This is just a convenience that simplifies the expansion program, EXP1. (See listing 2.) If the data were actually being sent to a serial output port, only minor changes in the code would be required.

The second compression program, COMP2, uses the same basic compression method as COMP1. (See listing 3.) However, the resulting serial bit stream is broken into 8-bit bytes for use by a parallel storage medium such as programmable memory. This provides maximum compression in a fixed-word-length computer. The program

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*Trademark of Digital Research **Trademark of Small Business Applications, Inc. EXP2 expands the compressed text created by COMP2. (See listing 4.) The description of the compression and expansion programs emphasizes the table structure, since both programs use tables to facilitate changing codes.

COMP1 Description

This program takes characters entered via the keyboard, checks for a legal character, finds the Huffman code corresponding to the entered character, and stores the bit stream sequentially in memory. Each bit is stored in the lowest-order bit of a byte for demonstration convenience and for interfacing with EXP1. The first two words of the output buffer contain a count of the number of bits that are stored in the remainder of the buffer. This information is used by EXP1 to stop the decoding process on the bit stream. The input need not come from the keyboard and could be from another buffer, simply by changing a few lines of code related to the input function.

The heart of the program's operation is the table lookup and the shifting function. Based upon a letter's ASCII code, an index is computed that is then added to the base address of the encoding table. This table has the following format: two 8-bit words are required for each letter to be encoded; the low-order 4 bits of the first word in memory contain a count of the number of bits required to encode the letter. The remaining 12 bits, 8 in the second byte followed by 4 in the top half of the first byte, are used to store the compressed code. (Note that the word order in the source statement and in memory is reversed because of the assembler's treatment of the DW (Define Word) instruction. The code is stored leftjustified in the 12-bit area. This format makes processing simple when the two words are loaded into the D and E register pair for shifting.

With the compressing code located, it is serialized by shifting left according to the count in the 4-bit part of the table. The DAD (add register pair to H and L) instruction effectively shifts the DE register pair's high-order bit into the carry register. As each bit is shifted out, the total bit count in the buffer is updated. The processing of the input stream continues until a period is detected, and control returns to the system monitor.

It should be noted that the only characters that are encoded are the twenty-six alphabetic letters. Any other characters (including blanks) are ignored. In a nondemonstration environment, spaces, punctuation, and other symbols would have to be included; this would require enlarging the lookup table to include the representation of the new symbols.

EXP1 Description

The expansion program, EXP1, operates on the bit stream prepared by COMP1. (See listing 2.) It expects this data to be in the buffer defined by COMP1, with the bit count in the first two words and the data bit in the lowest bit of each byte. This program is also table-driven; but the table is more complex than the encoding table and the processing is more involved. Basically, the program searches a binary tree to decode the bit stream. The binary tree shown in figure 2 is converted to a table. The program then steps through the table, selecting the appropriate branch in the tree structure depending upon the value of each bit in the data stream. The data in the table

Text continued on page 246

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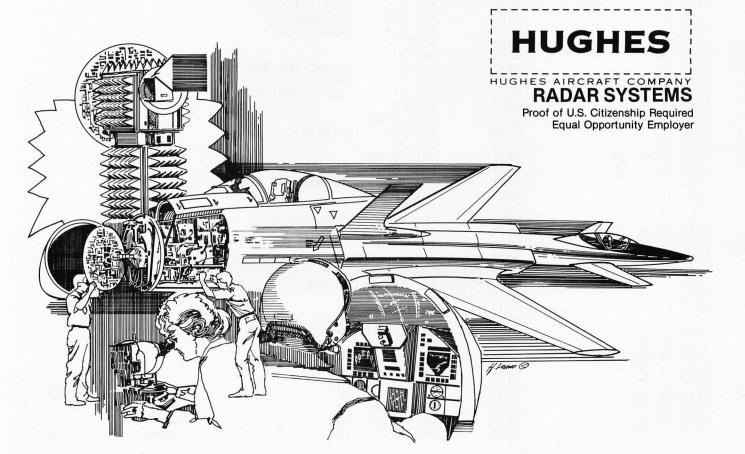
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Listing 1: COMP1 text-compression routine. This routine takes only alphabetic text entered from the keyboard and converts it to the Huffman code given by the tree in figure 2. The Huffman code is stored 1 bit per byte. The routine is written in 8080 machine code.

```
0001 *THIS ROUTINE TAKES TEXT, (LETTERS ONLY)
0002 *AND COMPRESSES THEM USING HUFFMAN CODING. FOR
0003 *TEST PURPOSES THERE IS ONE BIT PER BYTE IN THE
2500
2500
2500
                             0004 *DATA BUFFER. THE FIRST TWO BYTES IN THE DATA BUFFER
2500
                             0005 *ARE THE BIT COUNT. ENCODED DATA IS STORED IN DBUF AS 1 BIT
2500
2500
                             0006 *PER BYTE FOR TEST PURPOSES. NORMALLY DATA WOULD BE PACKED
2500
                             0007 *OR OUTPUTTED SERIALLY
                             0010 ECHO: EQU OC500H ;OUTPUT DRIVER
2500
                                          EQU 6
2500
                             0013
                                   SP:
                             0012 MON:
                                        EQU OCH
2500
                                                       ; MONITOR RETURN
2500
     31 00 00
                             0020
                                          LXI SP,0
2503
                             0021
                                          SHLD DBUF ; COMPRESSED BIT COUNT LXI H, DBUF+2
                                          LXI H, C
     21 00 00
     22 00 41
2506
                             0022
2509 21 02 41
                             0023
250C
     22 8C
                                                       ; NEXT BIT LOCATION
             25
                             0024
                                          SHLD DADD
250F
     DB
         08
                             0040 INCH:
                                          IN 8
2511 OF
                             0041
                                          RRC
2512 DA OF
             25
                             0042
                                          JC INCH
2515 DB 04
                             0043
                                          IN 10
                                          CPI '.'
2517 FE 2E
                                                       END OF TEXT
                             0060
2519 CA OC
            00
                             0070
                                          JZ MON
                                                       :NO MORE
251C
     CD 00 C5
                             0073
                                          CALL ECHO
                             0075
251F E6
                                          ANI 07FH
         7F
                                                       CLEAR PARITY
                                          SUI 'A'
2521 D6 41
                             0080
                                                       COMPUTE INDEX
                                          JC INCH
2523 DA OF
             25
                             0082
                                          CPI 'Z'-'A'+1
2526 FE 1A
                             0084
2528 D2 OF 25
                             0086
                                          JNC INCH
252B 87
                             0090
                                          ADD
                                                       ; MULTIPLY BY 2
252C
                                          MOV C, A
                             0100
     4F
252D 06
                                          MVI B, 0
         00
                             0110
252F 21
                             0120
                                          LXI H, TABL
         58 25
                                                       ; INDEX
2532 09
                                          DAD B
                             0130
                                          MOV E,M
2533 5E
                                                       GET ENCODE VALUE
                             0140
2534 23
                             0150
                                          INX H
                                          MOV D, M
2535
      56
                             0160
                                                       GET BIT COUNT
                             0170
2536
     7B
                                          MOV A, E
2537 E6
                             0180
                                          ANI OFH
                                                       : MASK COUNT
         OF
2539 47
                                          MOV B, A
                             0185
                                                       : KEEP COUNT
253A EB
                                          XCHG
                             0187
253B AF
253C 29
                             0190 NEXT:
                                         XRA A
                             0192
                                                       SHIFT OUT BIT STREAM
     29
                                          DAD H
253D
                                                       MSB FIRST
     17
                             0200
                                          RAL
253E E6
                             0220
         01
                                          ANI 1
                                                       SETUP OUTPUT BIT
2540 E5
                             0225
                                          PUSH H
2541 2A
         8C 25
                             0226
                                          LHLD DADD
2544
2545
                                          MOV M, A
     77
                             0228
                                                       STORE BIT
                             0229
                                          INX H
2546 22 8C 25
                             0231
                                          SHLD DADD
2549 2A 00 41
                             0232
                                          LHLD DBUF
254C 23
                             0235
                                          INX H
                                                       :UPDATE BIT COUNT
254D 22 00 41
                             0236
                                          SHLD DBUF
2550 E1
2551 05
                             0238
                                          POP H
                             0260
                                          DCR B
                                                       ; REDUCE COUNT
2552 C2
         3B 25
                             0270
                                          JNZ NEXT
2555 C3 OF 25
                             0300
                                          JMP INCH
2558
                             0305
                                   *ENCODE TABLE FORMAT- LOW ORDER 4 BITS ARE NUMBER OF BITS
2558
                                   *IN ENCODED CHARACTER. REMAINING 12 BITS ARE FOR CODE.
                             0306
                             0307 *CODE IS LEFT JUSTIFIED. E.G., AN M IS 00011 0310 TABL: DW 0F004H ; A
2558
2558 04 FO
                                                       ; B
255A 06 70
                             0320
                                          DW 7006H
255C 05 40
                             0330
                                          DW 4005H
                                                       ;D
255E 05 D8
                             0340
                                          DW 0D805H
                                                       ;E
2560 03 80
                             0350
                                          DW
                                             8003H
                                                       ;F
2562
     05
                             0360
                                          DW 4805H
         48
                                                       ;G
2564 05 08
                             0370
                                          DW 805H
2566
     04 50
                             0380
                                          DW 5004H
                                                       ; H
                                                       ;I
                             0390
                                          DW 0A004H
2568 04
         A0
                                                       ;J
256A 09 D0
                             0400
                                          DW ODOO9H
                                                       ; K
256C
      89 D1
                             0410
                                          DW
                                              0D189H
                                          DW 7805H
256E 05 78
                             0420
                                                       ;L
                                                                                  Listing 1 continued on page 230
```

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Connect your Apple, TRS-80 or any other computer or terminal to the phone lines!



Penril 300/1200—Bell 212A style \$799 Bell 212A style. 1200 baud and 300 baud. Manual originate, auto-answer. Full duplex. RS232. Direct connect to phone lines via RJ11C standard extension phone voice jack. 1 year warranty.



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& PRINTERS



DEC LA120

Digital Equipment Corporation

DEC LA120 ... \$2388

180 CPS. Dot matrix. Upper/lower case. 1K buffer. Designed for 1200 baud communications. 30 character answerback message. Adjustable line spacing. Adjustable character sizes including double sized characters. Settable horizontal and vertical tabs. Top-of-form capability, RS232.

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Bantam 550B \$694 Compact. Silent. Upper/lower case. 80th col. wrap-around. Bell. Integrated numeric pad. Printer port. Transparent mode. Editing features. Tabbing.

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Digital

Corp.

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550 Options

20mA Current Loop Interface \$70 Non-Glare Screen \$25 2nd page of memory (550S only).. \$100

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30 CPS. Dot matrix. Upper/lower case. 4 character sizes. Up to 217 cols per line. 6 lines per inch settings. Friction feed. Settable tabs. RS232.

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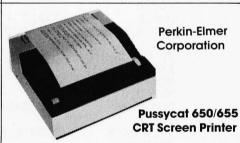
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650/655 Pussycat CRT Screen Printer. \$899 100 CPS. Extremely compact and quiet. 110 to 9600 baud rate. 2K buffer. Ideal for producing rapid, reliable hardcopy of your CRT screen display. Can be added to any CRT with our interface option.

tion and tractor feed

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```
Listing 1 continued:
                             0430
2570 05 18
                                          DW 1805H
2572 04 CO
                             0440
                                          DW 0C004H
                                                       , N
                             0450
                                                       ;0
2574 04 E0
                                          DW 0E004H
                             0455
                                          DW 0D406H
                                                       ; P
2576 06 D4
2578 4A D1
257A 04 B0
257C 04 60
                                                       ; 0
                             0460
                                          DW OD14AH
                                                       Ř
S
T
                             0470
                                          DW 0B004H
                             0480
                                          DW 6004H
257E 03 20
                             0490
                                          DW 2003H
2580 05 10
                             0500
                                          DW 1005H
                                                       , U
2582 07 D2
                             0510
                                          DW 0D207H
                                                       ;V
                                                       ;W
                             0520
                                          DW 7406H
2584 06
         74
                                                       ; X
                             0530
2586 89 DO
                                          DW 0D089H
2588 05 00
                             0540
                                          DW 5H
                                                       Y
258A 0A D1
                             0550
                                          DW ODIOAH
                                                       NEXT BIT LOCATION
258C 00 00
                             0600 DADD: DW 0
                                          ORG 4100H
258E
                             0605
4100
                             0610 DBUF: DS 1000
```

Listing 2: EXP1 text-expansion routine. This routine takes the output of COMP1, information expressed in a Huffman code, and decodes it using the binary tree of figure 2. The decoded character is displayed via a user-supplied subroutine named DISP. The routine is written in 8080 machine code.

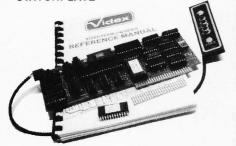
		DATA PREPARED BY THE DATA COMPRESSION
3000 0001	*(HUFFMAN CODE) PROGR	AM. THE DATA BUFFER HAS THE BIT COUNT
		ES. THE PROGRAM RUNS UNTIL ALL BITS
		THE PROCESSING CONSISTS OF ADDING A
		E ENTRY POINT, GETTING AN INCREMENT
		NEXT 0-1 PAIR AND CONTINUING UNTIL
3000 0006	*A TAG IS FOUND IN BI	T 7. THIS SIGNIFIES THAT THE NEXT
		ESIRED CHARACTER, IN A NON-TEST MODE
		PACKED IN 8 BIT BYTES OR ARRIVING
3000 0009	*VIA A SERIAL PORT.	
3000 01 00 00 0010		
3003 21 02 41 0020	The state of the s	;FIRST BIT
3006 22 97 30 0030	SHLD DADD	; NEXT DATA ADDRESS
3009 21 00 41 0040	LXI H, DBUF	;BIT COUNT
300C 4E 0050	MOV C,M	
300D 23 0060		
300E 46 0070	MOV B, M	
300F C5 0080	EXP: PUSH B	
3010 21 4B 30 0090		; DECODE TABLE
	NEXT: PUSH H	
3014 2A 97 30 0110		
3017 4E 0120	MOV C,M	; DATA VALUE
3018 23 0130		
3019 06 00 0140	MVI B, O	
301B 22 97 30 0150	SHLD DADD	
301E El 0160	POP H	
301F 09 0170	DAD B	;TABLE + DATA BIT
3020 7E 0180	MOV A, M	; GET POINTER
3021 17 0190	RAL	
3022 DA 32 30 0200	JC OUTCH	
3025 1F 0205		
3026 5F 0210		
3027 15 00 0220	MVI D,0	
3029 19 0230		;TABLE+DATA BIT + POINTER
302A C1 0240		
302B CD 44 30 0250		; REDUCE BIT COUNT
302E C5 0270		
302F C3 13 30 0280		
	OUTCH: RAR	
3033 E6 7F 0294		;REMOVE TAG
3035 5F 0296		
3036 16 00 0297		
3038 19 0298		
3039 7E 0299		GET DECODED CHARACTER
303A CD 00 C5 0305		
303D C1 0310		
303E CD 44 30 0320		7 0 1
3041 C3 OF 30 0330	JMP EXP	Listing 2 continued on page 232

The Text Solution for APPLE II®

Now APPLE II® Owners Can Solve Text Problems With VIDEOTERM 80 Column by 24 Line Video Display Utilizing 7 X 9 Dot Character Matrix

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VIDEOTERM lists BASIC programs, both Integer and Applesoft, using the entire 80 columns. Without splitting keywords. Full editing capabilities are offered using the ESCape key sequences for cursor movement. With provision for stop/start text scrolling utilizing the standard Control-S entry. And simultaneous on-screen display of text being printed.

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Firmware

1K of on-board ROM firmware controls all operation of the VIDEOTERM. No machine language patches are needed for normal VIDEOTERM use.

Firmware Version 2.0

Characters Options

7 x 9 matrix 7 x 12 matrix option; Alternate user definable character set option; Inverse video option. Display 24 x 80 (full descenders) 18 x 80 (7 x 12 matrix with full descenders)

! * * * * * ' () * + , - . / • i 2 3 4 5 6 7 8 9 ; ; <= >? • A B C D E F G H I J K L H N O • P OR S T U V W X Y Z I \ 1 1 _ ' a b c d e f g h i j k | m n o • p q r s t u v w x y z { i } * \$

> 7X9 MATRIX 24X80 STANDARD

Want to know more? Contact your local Apple dealer today for a demonstration. VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon. Or send for the VIDEOTERM Owners Reference Manual and deduct the amount if you decide to purchase. Upgrade your Apple II* to full terminal capabilities for half the cost of a terminal. VIDEOTERM. At last.

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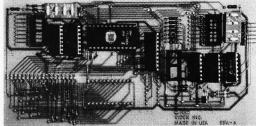
ACCESS ALL YOUR KEYBOARD ASCII CHARACTERS

Videx has the perfect companion for your word processor software: the KEYBOARD AND DISPLAY ENHANCER. Install the enhancer in your APPLE II and be typing in lower case just like a typewriter. If you want an upper case character, use the SHIFT key or the CTRL key for shift lock. Not only that, but you see upper and lower case on the screen as you type. Perfectly compatible with Apple Writer and other word processors like, for example, Super-Text.

If you want to program in BASIC, just put it back into the alpha lock mode; and you have the original keyboard back with a few im-

provements. Now you can enter those elusive 9 characters directly from the keyboard, or require the Control key to be pressed with the RESET to prevent accidental resets.

KEYBOARD AND DISPLAY ENHANCER is recommended for use with all revisions of the APPLE II. It includes 6 ICs, and EPROM and dip-switches mounted on a PC board, and a jumper cable. Easy installation, meaning no soldering or cutting traces. Alternate default modes are dip-switch selectable. You can even remap the keyboard, selecting an alternate character set, for custom applications.



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VISA

```
Listing 2 continued:
                                0340 DECB:
                                                                   :REDUCE BIT COUNT
3044 OB
                                                 DCX B
3045 79
                                                 MOV A,C
                                0350
                                0360
                                                 ORA B
3046 BO
3047 CA OC
             00
                                0365
                                                 JZ MON
                                0370
                                                 RET
304A C9
                                4000 *THE DECODE TABLE HAS THE FOLLOWING FORMAT:
304B
                                4010 *THE TABLE VALUE IS THE INCREMENT NECESSARY TO GET TO THE
304B
                                4020 *NEXT 0-1 PAIR AS THE PROGRAM STEPS THROUGH THE DATA.
4030 *THE TABLE VALUE JUST PRECEDING A CHARACTER HAS A TAG
4040 *SET IN BIT 7, IN ADDITION TO THE INCREMENT, TO INDICATE
4050 *THAT THE NEXT VALUE IA A CHARACTER.
304B
304B
304B
304B
                                                                   ;0
                                                 DB 42
                                                                       0
304B 2A
                                5000 XTAB:
                                                                   ;1
 304C
                                5010
                                                 DB
                                                    1
                                                                        1
      01
                                                                   ; 2
                                5020
                                                    2
 304D
      02
                                                 DB
                                                                        0
                                                    8
304E 08
                                5030
                                                 DB
                                                                        1
304F 82
                                5040
                                                 DB
                                                    130
                                                                   ;4
                                                                        0
                                                                   ;5
                                                                        1
3050 02
                                5050
                                                 DB 2
                                                                   ;6
3051 45
                                                 DB
                                                    'E'
                                5060
                                                                        0
 3052 82
                                5070
                                                 DB
                                                    130
                                5080
                                                    130
                                                                   ;8
3053 82
                                                 DB
                                                                        1
                                                                   ;9
3054 49
                                                    ' I'
                                5090
                                                 DB
                                                                   ;10
3055 52
                                5100
                                                    'R'
                                                 DB
3056 06
3057 01
                                5102
                                                 DB
                                                    6
                                                                   ;11
                                                                        0
                                                                   ;12
                                5104
                                                 DB
                                                    1
                                                                       1
                                                                   ;13
                                                    130
 3058 82
                                5106
                                                 DB
                                                                        0
                                                                   ;14
3059 82
                                5108
                                                 DB
                                                    130
 305A 4F
                                                    101
                                5110
                                                 DB
                                                                   ;15
                                                    1 A
305B 41
                                5120
                                                                   ;16
                                                 DB
 305C 82
                                5130
                                                    130
                                                                   ;17
                                                                        0
                                                 DB
                                                                   ;18
305D 02
                                5140
                                                 DB
                                                                       1
                                                    2
                                                                   ;19
 305E 4E
                                5150
                                                 DB
                                                     'N'
                                                                   ;20
                                                    3
 305F 03
                                5160
                                                 DB
                                5170
                                                    129
3060 81
                                                 DB
                                                                   ;21
                                                                        1
                                                                  ;22;23
                                                    'D'
3061 44
                                5180
                                                 DB
                                                    3
3062 03
                                5190
                                                 DB
                                                                   ;24
 3063 81
                                5200
                                                 DB
                                                    129
                                                                   ;25
 3064 50
                                5210
                                                 DB
                                                     'P'
 3065 03
                                5220
                                                 DB
                                                    3
                                                                   ;26
 3066 81
                                5230
                                                    129
                                                                   ;27
                                                 DB
                                                                       1
                                                                   ;28
;29 0
3057 56
                                                    111
                                5240
                                                 DB
                                                    2
3068 02
                                5250
                                                 DB
                                                                   ;30 1
3069 05
                                                    5
                                5260
                                                 DB
                                                 DB 130
                                                                    31 0
306A 82
                                5270
306B 82
                                5280
                                                 DB
                                                    130
                                                                   ;32
                                                    1,71
                                                                   ;33
306C 4A
                                5290
                                                 DB
 306D 58
                                5300
                                                    'X'
                                                                   :34
                                                 DB
                                                                   ;35
                                                    3
306E 03
                                5310
                                                 DB
                                                    129
306F 81
                                5320
                                                 DB
                                                                   ;36
                                                                   ;37
                                                    'K'
3070 4B
                                5330
                                                 DB
                                5340
3071 82
                                                 DB
                                                    130
                                                                    38
3072
                                5350
                                                                   ;39
      82
                                                 DB
                                                    130
                                                                       1
3073 5A
                                5360
                                                    1Z1
                                                                   ;40
                                                 DB
                                                    1 01
 3074 51
                                5370
                                                 DB
                                                                   :41
3075 02
                                                    2
                                                                   ;42 0
                                5380
                                                 DB
                                5390
                                                                   ;43 1
3076 OE
                                                 DB
                                                    14
3077 03
3078 81
                                5400
                                                 DB
                                                    3
                                                                   :44
                                                                       0
                                                    129
                                5410
                                                 DB
                                                                   ;45
                                                                       1
                                                    'T'
3079 54
                                5420
                                                 DB
                                                                   ;46
                                                                   ;47
307A 02
                                5430
                                                 DB
                                                    2
                                                                  ;48
307B 05
                                5440
                                                 DB
                                                                       1
                                                                   ;49
307C
      82
                                5450
                                                DB
                                                    130
                                                                       0
                                5460
                                                                    50
307D 82
                                                 DB
                                                    130
                                                                       1
                                                    'Y'
                                                                   ;51
307E 59
                                5470
                                                DB
307F 47
                                5480
                                                 DB
                                                    'G'
                                                                    52
3080 82
                                                                    53
                                5490
                                                DB 130
                                                                       0
3081 82
                                5500
                                                DB
                                                    130
                                                                    54
                                                                       1
3082 55
                                5510
                                                 DB
                                                    יטי
                                                                    55
3083 4D
                                                                    56
                                5520
                                                DB
                                                    'M'
                                                    2
                                5530
 3084 02
                                                                    57
                                                DB
                                                                  ;58
3085 08
                                5540
                                                DB
                                                                       1
                                                                   ;59
3086 03
                                5550
                                                DB
                                                    3
3087 81
                                5560
                                                DB 129
                                                                   ;60 1
                                                                                         Listing 2 continued on page 234
```

DIGITAL HARMONY

A new synthesis of sight and sound



Digital Harmony by John Whitney

Digital Harmony lays the foundation for the whole new field of audio-visual art made possible by microcomputers. John Whitney, a pioneer of the special effects technology used in STAR WARS and 2001: A SPACE ODYSSEY, explains the special union of computer graphics and music. His computer-generated visual art graphically depicts the laws of harmonic motion common to all music.

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John Whitney is on the Faculty in the Department of Art at the University of California, Los Angeles.

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	sed in the am		

BYTE April 1981

```
Listing 2 continued:
                                           DB 'H'
                             5570
                                                            ;61
3088 48
                                                            ;62 0
3089 82
                             5580
                                           DB 130
                             5590
                                                            ;63
                                           DB 130
308A 82
                                           DB 'C'
                                                            ; 64
308B 43
                             5600
                                                            ;65
                                           DB 'F'
                             5610
308C 46
                                           DB 130
308D 82
                             5620
                                                            ;66
308E
     02
                             5630
                                           DB
                                               2
                                                            ;67
                                               151
                                                            ;68
                             5640
308F 53
                                           DB
                                           DB 3
                             5650
3090 03
                                                            :69
                                                            ;70
                                           DB 129
3091 81
                             5660
                                                            ;71
3092 4C
                             5670
                                           DB 'L'
                                                            ;72
3093 82
                             5680
                                           DB 130
3094 82
                             5690
                                           DB
                                               130
                                                            ;73
                                                                1
                                                            ;74
3095 42
                             5700
                                           DB 'B'
3096 57
                             5710
                                           DB 'W'
                                                            : 75
                                                            NEXT DATA ADDRESS
3097 02 41
                             5720 DADD:
                                           DW DBUF+2
3097
                             5999
                                            ORG 4100H
4100
                             6000 DBUF:
                                            DS 1000
44E8
                             9000 DISP:
                                            EQU OC500H
                                                            DISPLAY A CHARACTER
                             9010 MON
                                            ECU 000CH
44E8
                                                            MONITOR RETURN
                             9020 SP:
                                            EQU 0
44E8
```

Listing 3: COMP2 text-compression routine. This routine is identical to COMP1 (listing 1) except that the Huffman code information is packed and stored 8 bits to the byte. The routine is written in 8080 machine code.

```
2600
                            0001 *THIS ROUTINE TAKES TEXT (LETTERS ONLY)
                                 *AND COMPRESSES THEM USING HUFFMAN CODING.
2600
2600
                            0004 *THE FIRST TWO BYTES IN THE DATA BUFFER
2600
                            0005 *ARE THE BIT COUNT. ENCODED DATA IS STORED IN DBUF
                            0006 *IN A PACKED FORM, 8 BITS TO THE BYTE. 0010 ECHO: EQU 0C500H; OUTPUT DRIVER
2600
2600
                            0011 SP:
2600
                                        EQU 6
2600
                            0012 MON: EQU OCH
                                                     MONITOR RETURN
2600
     31 00 00
                            0020
                                         LXI SP, 0
2603 21
                            0021
         00 00
                                        LXI H, O
                            0022
2606 22
         00 41
                                         SHLD DBUF
                                                     COMPRESSED BIT COUNT
2609 21
                            0023
         02 41
                                         LXI H, DBUF+2
260C 22
         BA 26
                            0024
                                         SHLD DADD
                                                     NEXT BIT LOCATION
260F AF
                            0025
                                        XRA A
2610 32
         BC
                            0026
                                         STA POS
            26
2613 DB
         08
                            0040 INCH:
                                        IN 8
                                                     ; INPUT CODE
2615 OF
                                        RRC
                            0041
2616 DA
        13
            26
                            0042
                                        JC
                                           INCH
2619 DB OA
                                        IN 10
                            0043
                                        CPI '.'
261B FE
                            0045
         2E
                                                     ; END OF TEXT
                                        JNZ PROS
261D C2 37
                            0047
2620 2A BA 26
                            0050
                                        LHLD DADD
                                                     CLEAN UP PARTIAL BYTE
2623 3A BC 26
                            0052
                                        LDA POS
                                        MOV B, A
2626 47
                            0054
                                                     COMPUTE SHIFT COUNT
2627 3E
                                        MVI A,8
         08
                            0056
2629 90
                            0058
                                        SUB B
262A E6
                            0060
                                        ANI
262C 47
                                        MOV B, A
                                                     : KEEP SHIFT COUNT
                            0062
                                        MOV A, M
262D 7E
                            0064
                                                     GET PACKED BYTE
262E CA
                                        JZ MON
         OC 00
                            0066 SHFT:
                                                     ; FIN ISHED
2631 17
                                        RAL
                            0068
2632 05
                            0070
                                        DCR B
2633 77
                            0071
                                        MOV M. A
                                                     REPLACE PACKED BYTE
                            0072
2634 C3
         2E 26
                                        JMP SHFT
2637 CD
         00 C5
                            0073
                                 PROS: CALL ECHO
                            0075
263A E6
         7F
                                        ANI O7FH
                                                     CLEAR PARITY
                                        SUI 'A'
263C D6
                            0080
                                                     COMPUTE INDEX
263E DA 13
            26
                            0082
                                        JC INCH
                                        CPI 'Z'-'A'+1
2641 FE
                            0084
        1A
2643 D2
         13 26
                            0086
                                        JNC INCH
2646 87
                            0090
                                        ADD A
                                                     :MULTIPLY BY 2
                                        MOV C, A
2647 4F
                            0100
2648 06 00
                            0110
                                        MVI B, 0
264A 21
         86 26
                            0120
                                        LXI H, TABL
264D 09
                            0130
                                        DAD B
                                                     : INDEX
                                                                               Listing 3 continued on page 236
```

THE ADVANTAGES OF THE FUNCTIONAL GROUP:



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Share the advantages with us.





```
Listing 3 continued:
                                        MOV E,M
                                                     GET ENCODE VALUE
                            0140
264E 5E
                                        INX H
264F 23
                            0150
                                        MOV D,M
                            0160
2650 56
                                                     GET BIT COUNT
                                        MOV A, E
2651 7B
                            0170
                                        ANI OFH
                                                     MASK COUNT
2652 E6
         OF
                            0180
                                        MOV B, A
                                                     KEEP COUNT
                            0185
2654 47
                                        XCHG
2655 EB
                            0187
2656 AF
2657 29
                            0190 NEXT: XRA A
                                                     ; SHIFT OUT BIT STREAM
                            0192
                                        DAD H
                                                     ; MSB FIRST
2658 17
                            0200
                                        RAL
                                                     SETUP OUTPUT BIT
                                        ANI 1
2659 E6 01
                            0220
                            0225
                                        PUSH H
265B E5
                                        LHLD DADD
265C 2A BA 26
                            0226
265F 57
                            0228
                                        MOV D, A
                            0229
                                        LDA PÓS
2660 3A BC 26
                                        MOV E, A
                                                     ; KEEP CURRENT POSITION
2663 5F
                            0231
                                        MOV A, M
2664
     7E
                            0233
                                                     GET OLD PACKED DATA
2665 17
                                                     MAKE ROOM
                            0235
                                        RAL
2666 B2
                            0237
                                        ORA D
                                                     : PACK
2667 77
                                        MOV M, A
                                                     : PUT IT AWAY
                            0239
                                                     UPDATE POSITION
                            0240
                                         INR E
2668 1C
                                        MOV A,E
2669 7B
                            0242
266A FE
                            0244
                                                     ;FULL BYTE?
         74 26
                                        JNZ STOR
266C C2
                            0246
266F AF
                            0248
                                        XRA A
                                                     : INITIALIZE POSITION
2670 23
                            0250
                                         INX H
                                                     ; UPDATE DADD
                            0252
                                        SHLD DADD
2671 22
        BA 26
2674 32 BC 26
2677 2A 00 41
                            0258 STOR: STA POS
                            0260
                                        LHLD DBUF
267A 23
                            0262
                                         INX H
                                                     ; UPDATE BIT COUNT
267B 22
267E E1
                            0264
                                        SHLD DBUF
         00 41
                            0266
                                         POP H
                                                     : REDUCE COUNT
267F 05
                            0268
                                        DCR B
2680 C2 56 26
                            0270
                                        JNZ NEXT
                            0300
                                        JMP INCH
2683 C3 13 26
                            0305 *ENCODE TABLE FORMAT- LOW ORDER 4 BITS ARE NUMBER OF BITS
2686
                            0306 *IN ENCODED CHARACTER.REMAINING 12 BITS ARE FOR CODE.
2686
2686
                            0307 *CODE IS LEFT JUSTIFIED. E.G., AN M IS 00011.
                            0310 TABL: DW 0F004H
2686 04 F0
                                        DW 7006H
2688 06 70
                            0320
                                                     ; B
                                                     ;C
268A 05 40
                            0330
                                        DW 4005H
268C
     05
        D8
                            0340
                                        DW 0D805H
                                                     ;D
                            0350
                                        DW 8003H
                                                     ;E
268E 03 80
                            0360
                                        DW 4805H
2690 05 48
                                                     ;F
                                                     ;G
2692 05 08
                            0370
                                        DW 805H
2694 04 50
                                                     ; H
                                        DW 5004H
                            0380
                                                     ;I
2696 04
         AO
                            0390
                                        DW 0A004H
                                                     ;J
2698 09
         D<sub>0</sub>
                            0400
                                        DW 0D009H
269A 89 D1
                            0410
                                        DW 0D189H
                                                     ; K
269C 05
                                        DW 7805H
                                                     ;L
        78
                            0420
269E 05 18
                            0430
                                        DW 1805H
26A0 04 C0
                            0440
                                        DW 0C004H
                                                     ; N
                                                     ;0
26A2 04 E0
                            0450
                                        DW 0E004H
                                                     ; P
26A4 06 D4
                            0455
                                        DW 0D406H
26A6 4A D1
                                                     ,Q
                                        DW OD14AH
                            0460
                                                     ;R
                                        DW OBOO4H
26A8 04 B0
                            0470
                                                     ;S
26AA 04 60
                            0480
                                        DW 6004H
                                        DW 2003H
                            0490
                                                     ;T
26AC 03 20
26AE
     05
         10
                            0500
                                        DW 1005H
                                                     ; V
26BO 07 D2
                            0510
                                        DW 0D207H
                                                     ; W
26B2 06 74
                            0520
                                        DW 7406H
                                                     ;X
26B4 89 D0
                            0530
                                        DW 0D089H
26B6 05 00
                            0540
                                        DW 5H
                                                     , Y
26B8 OA D1
                            0550
                                        DW
                                            OD 10AH
26BA 00 00
                            0600 DADD:
                                        DW
                                            0
                                                     NEXT BIT LOCATION
                            0603 POS:
                                                     BIT POSITION
26BC
                                        DS 1
26BD
                            0605
                                        ORG 4100H
4100
                            0610 DBUF: DS 1000
```

WAITA MINUTE, WE CAN SAYE YOU 1,000.

With the Starwriter™ Daisy Wheel 25 cps printer from C. Itoh.

A business letter, written on a 45 cps word-processing printer, might take about two minutes to print.

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The Starwriter 25 comes complete and ready-to-use, requiring no changes in hardware or software. It uses industry-standard ribbon cartridges, and it's "plug-in" compatible to interface with a



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Using a 96-character wheel, it produces excellent letter-quality printing on three sharp copies with up to 163 columns, and offers the most precise character-placement available, for outstanding print performance.

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Leading Edge Products, Inc., 225 Turnpike Street, Canton, Massachusetts 02021

Dear Leading Edge: I'd like to know more about the Starwriter, and how spending a minute can save me a grand. Please send me the name of my nearest dealer.

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Title	
Company	A STATE OF THE STA
Street	There is a second
State	Zip
Phone: Area Code	
Number	

LEADING EDGE.

Listing 4: EXP2 text-expansion routine. This routine takes the output of COMP2, information expressed in a packed Huffman code, and decodes it using the binary tree of figure 2. The decoded character is displayed via a user-supplied subroutine named DISP. The routine is written in 8080 machine code.

3000 00	000 *THIS P	ROGRAM ACCEPTS	DATA PREPARED BY THE DATA COMPRESSION	
3000	001 *(HUFFM	AN CODE) PROGRA	AM THE DATA BUFFER HAS THE BIT COUNT	
3000	002 *IN THE	FIRST TWO BYTE	ES. THE PROGRAM RUNS UNTIL ALL	
3000 00	003 *BITS H	AVE BEEN PROCES	SSED THE PROCESSING CONSISTS OF	
3000 00	004 *ADDING	*ADDING A DATA BIT TO THE TABLE ENTRY POINT, GETTING AN		
		*INCREMENT WHICH POINTS TO THE NEXT 0-1 PAIR AND CONTINUING		
		*UNTIL A TAG IS FOUND IN BIT 7 THIS SIGNIFIES THAT THE		
		*NEXT TABLE ENTRY IS THE DESIRED CHARACTER.		
			ERSION WHICH PROCESSES DATA FROM	
		BYTES, MSB FIRS		
	010 DISP:	EQU OC500H	;DISPLAY CHARACTER	
	011 MON:	EQU 000CH	; MONITOR RETURN	
	012 SP:	EQU 6		
3000 31 00 00	015	LXI SP,0		
3003 21 02 41 00	020	LXI H, DBUF+2	:FIRST BIT	
3006 22 CO 30 00	030	SHLD ĎADD	NEXT DATA ADDRESS	
	040	LXI H, DBUF	BIT COUNT	
	050	MOV C,M		
	060	INX H		
	070	MOV B, M		
	074	MVI A, 1	; INITIALIZE POSITION	
	076	STA POS	, In II IABIBE TOOTI TON	
	080 EXP:	PUSH B	DECODE MARKE	
	090	LXI H, XTAB	;DECODE TABLE	
	100 NEXT:	PUSH H		
	110	LHLD DADD		
301C 3A C2 30 0	120	LDA POS	GET BIT POSITION	
301F 47 0	122	MOV B, A		
3020 7E 0	124	MOV A, M	GET DATA	
	126 BIT:	RAL	GET DESIRED BIT INTO CARRY	
	128	DCR B		
	130	JNZ BIT		
	132	MVI A,0		
	134	RAL	RESTORE SINGLE BIT	
	136	MOV C, A	;DATA VALUE	
	140	MVI B, O		
	150	SHLD DADD		
	160	POP H		
	170	DAD B	; TABLE + DATA BIT	
	180	MOV A, M	GET POINTER	
	190	RAL		
3033 DA 43 30 03	200	JC OUTCH		
3036 1F 02	205	RAR		
3037 5F 02	210	MOV E, A		
3038 16 00 02	220	MVI D,0		
	230	DAD D	: TABLE+DATA BIT + POINTER	
	240	POP B		
	250	CALL DECB	REDUCE BIT COUNT	
	270	PUSH B	,	
	280	JMP NEXT		
	290 OUTCH:	RAR		
			- DEMOVE TAC	
	294	ANI 7FH	; REMOVE TAG	
	296	MOV E, A		
	297	MVI D, 0		
	298	DAD D		
	299	MOV A, M	; GET DECODED CHARACTER	
	305	CALL DISP		
304E C1 03	310	POP B		
304F CD 55 30 03	320	CALL DECB		
	330	JMP EXP		
	340 DECB:	DCX B	REDUCE BIT COUNT	
	350	MOV A,C		
	360	ORA B		
	365	JZ MON		
	370	LDA POS		
	380	INR A	;UPDATE BIT POSITION	
	385	STA POS	, OLDRIE BIL FOSTITON	
	390	CPI 9	. O DITC DDOCECCED?	
0.002 12 07		011	;8 BITS PROCESSED?	

DYNACOMP

Quality software for⁺:

ATARI APPLE II Plus TRS-80 (Level II)* **NORTH STAR** CP/M 8" Disk

GAMES, SIMULATIONS, EDUCATION and MISCELLANEOUS

BRIDGE 2.0 (Available for all computers)

An all-inclusive version of this most popular of eard games. This program both BIDS and PLAYS either contract or duplicate bridge.

Depending on the contract, your computer opponents will either play the offense OB defense. If you bid too high, the computer did double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge notice.

HEARTS 1.5 (Available for all computers)

Price: \$14.95 Cassette/\$18.95 Diskette
An exciting and enterraining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of paules. Play against two computer opponents who are armed with hard-obset playing strategies.

Price: \$11.95 Cassette/\$15.95 Diskette STUD POKER (ATARI only) UD POKER (A1 ARI only)

This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) the on what you see. This is the classic gambler's card game. The computer does not cheat and autually best the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. The package will run on a 16K ATARI. Collor, graphics, sometimes bluffs!

POKER PARTY (Available for all computers)

Price: \$17.95 Cassette/\$21.95 Diskette

REM PAKE Y (Available for all computers)

Potce: \$17.95 Cassette:\$21.95 Diskette

POKER PAKET y a draw poter simulation basted on the book, POKER, by Oswald Jacoby. This is the most compenensive version available for microcomputers. The party consists of yourself and six other (computer) players. Each of these players (you will get to know them) has a different personality in the form of a varying propensity to buffer of dol under pressure. Practice with POKER PAR-TY before going to that expensive game tonigh! Apple Cassette and diskette versions require a 32 K (or larger) Apple II.

VALDEZ (Available for all computers)

A simulation of supertanker navigation in the Prince William Sound and Valdez Narrows. The program uses an extensive 256x256 element radar map and employs physical models of ship response and tidal patterns. Chart your own course through ship and iceberg traffic. Any standard terminal may be used for display.

FLIGHT SIMULATOR (Available for all computers)

A realistic and extensive mathematical simulation of tak-off, flight and landing. The program utilizes aerodynamic equations and the characteristics of a real airfoil, you can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers.

CRIBBAGE 2.0 (TRS-80 only)

This is a well-designed and nicely executed two-handed version of the classic card game, cribbage. It is an excellent program for the cribbage player in search of a worthy opponent as well as the beginner wishing to learn the game, in particular the scoring and jargen the standard cribbage score board is continually shown at the top of the display (utilizing the TRS-80's graphics capabilities), with the cards shown underneals. The computer automatically socress and has nonneces the points using the traditional phrases.

CHESS MASTER (North Star and TRS-80 only)

This complete and very powerful program provides five levels of play, It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language (by SOPTWARE SPECIALISTS of California). Full graphics are employed in the TRS-80 version, and two widon of alphanometric dipplay are provided to accommodate North Statu such

STARTREK 3.2 (Available for all computers)

Price: 5 9.95 Cassette:/513.95 Diskette
This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise withou
warning while also attacking starbases in other quadrants. The Klingons faut stack with both light and beavy cruiters and more when
shot at The situation is hetcit when the Enterprise to beinged by three heavy cruiters and a starbase 5.05. is received! The Klingons age

SPACE TILT (Apple only)

CE TILT (Apple only)

Price: \$10.95 Cassette/\$14.95 Diskette

See the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets

maller and smaller 4. buill-in timer allows you to measure your skill against others in this habit-forming action game.

GAMES PACK I (Available for all computers)
GAMES PACK I contains the classic computer games of BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH
more. These games have been combined into one large program for ease in loading. They are individually accessed by a conven-

GAMES PACK II (Available for all computers)

GAMES PACK II includes the games CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. As with GAMES

PACK I, all the games are loaded as one program and are called from a menu.

Why pay \$7.95 or more per program when you can buy a DYNACOMP collection for just \$9.95?

NOMINOES JIGSAW (ATARI and TRS-80 only)

Price: \$16.95 Cassette/\$20.95 Diskette

NO MORE 3 1650 A sin for the same ophiscored Bythical pounts The igas we construct a bythical pounts with the same ophiscored Bythical pounts The igas we construct a bythical pounts with the complex construction of which there are of the upen. By thorough that the shapes must be legally connected, and by passents the shapes constructed to the same of t

MOVING MAZE (Apple only)

MOVING MAZE employs the games paddles to direct a puck from one side of a maze to the other. However, the maze is dynamically (and randomly built and is continually being modified. The objective is to cross the maze without touching (or being hit by) a wall. Scoring is by an elapsed time indicator, and three levels of play are provided.

Price: \$14.95 Cassette /\$18.95 Diskette
This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to
entire that the clidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for
accleration. This program employs Hi-Res graphics and is educational as well as challenging.

ACHER'S PFT 1 (April 2014)

TEACHER'S PET I (Available for all computers)

Price: \$ 9.95 Cassette/\$13.95 Diskette
This is the first of DYNACOMP's educational packages. Primarily intended for pre-school grade 3, TEACHER'S PET provides the
young student with counting practice, letter-word recognition and three levels of math skill exercise.

CRYSTALS (ATARI only)

A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

CRANSTON MANOR ADVENTURE (North Star only)

At last A comprehenive Adventure game for the North Star, CRANSTON MANOR ADVENTURE takes you into mysterious
CRANSTON MANOR where you extempt to gather felablous treasures. Lurking in the manor are wild animals and robots who will not
CRANSTON MANOR where you extempt to gather felablous treasures. Lurking in the manor are wild animals and robots who will not
current popular series of Adventure programs, making this game the top in its class. Play can be stopped at any time and the status
stored on distance. Requires 310.

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY
DYNACOMP now distributes the 20+ volume NSSE library. Most of these diskettes offer an outstanding value for the purchase price
write for details regarding the contents of this library and quantity (four or more) purchases.

Circle 154 on inquiry card.

Availability

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run within 16 Kg program sency space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET. TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard (IBM format) 8" CP/M floopp disks for systems running under MBASIC.

BUSINESS and UTILITIES

MAIL LIST II (Apple and North Star diskettes only)

This many-featured program now includes full alphabetic and zip code sorting as well as file merging. Entries can be retrieved by user-defined code, client name or 2ip. Code. The printion (Format allows the use of standard size address labels. Each diskette can store more than 1100 entries (single density North Star or Apple DOS 3.2); over 2200 with double density North Star or Apple DOS 3.3):

FORM LETTER SYSTEM (FLS) (Apple and North Star diskette only)

FLS may be employed to generate individually addressed form letters. The user creates the address file and separately composes the letter. FLS will then print form letters using each address. FLS is completely compatible with MAIL LIST II, which may be used to manage your address files.

FLS and MAIL LIST II are available as a combined package for \$37,95.

TEXT EDITOR I (Letter Writer)

Price: \$14.95 Cassette/\$18.95 Diskette paragraph indexing. This text editor is ideally A1 EDITION 1 (Letter Writer)

Price: \$14.95
An easy to use, line-oriented text editor which provides variable line widths and simple paragraph into suited for composing letters and is quite capable of handling much larger jobs. Available for all computers of the price of the pr

PERSONAL FINANCE SYSTEM (ATARI only)

PFS is a single disk menu oriented system composed of 10 programs designed to organize and simplify your personal finances. Features include a 300 transaction capacity; fast access; 26 optional user code; data retrieval by month, code or paye; cyptonal printing of reports; checkbook balancing; bar graph plotting and more. Also provides on the diskette is ATRAI DOS 2. FINDIT (North Star only)

VDIT (North Star only)

Price: \$19.95

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (eg: last name), Commercial (eg:) plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, three are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by crost-referencing two or three keywords.

DFILE (North Star only)

Price: \$19.95

This handy program allows North Star users to maintain a specialized data base of all files and programs in the stack of disks which invariably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

COMPARE (North Star only)

COMPARE is a single disk utility software package which compares two BASIC programs and displays the file size of the opportunity in bytes, the lengths in terms of the number of statement lines, and the line numbers at which various listed differences occur. COMPARE permits the user to examine versions of his software to verify which are the more current, and to clearly identify the changes made during development.

COMPRESS (North Star only)

COMPRESS is a single-disk utility program which removes all unnecessary spaces and (optionally) REMark statements from North Star BASIC programs. The source fie is processed one line at a time, thus permitting very large programs to be compressed using only a small amount of computer memory. File compressions of 20-50 % are commonly achieved.

GRAFIX (TRS-80 only)

Price: \$12.95 Cassette/\$16.95 Diskette

Price: \$12.95 Cassette: \$16.95 Diskette This unique program allows you to easily create graphics directly from the keyboard. You "fare" you figure using the program 's tensive cursor controls. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "hap-py face", call it Ha and then print it from your program using PRINT HIS This is a very easy way to create and save graphics.

DY (TRS-80 only)

Price: \$10.95 Cassette/\$14.95 Diskette
TIDV is an assembly language program which allows you to renumber the lines in your BASIC programs. TIDY also removes unnecessary spaces and REMark statements. The result is a compacted BASIC program which use much less memory space and execute
significantly faster. Once loaded, TIDV remains in memory; you may load any number of BASIC programs without having to reload
TIDV!

STATISTICS and ENGINEERING

DATA SMOOTHER (Not available for ATARI)

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic politing of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers)

Price: \$14.95 Cassette/\$18.95 Diskette
Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of
the imput data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer)
This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filt examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engine oriented decibel versus logs-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educa and scientific use. TFA is a majorienting tool. Available for all computers.

HARMONIC ANALYZER (Available for all computers)

Price: \$24.95 Cassette: \$25.95 Diskette
HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include data file generation, editing and storage/retrieval as well as data and spectrum plotting. One particularly unique facility is that the input data need not be
equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required by the FFT
algorithm. FOURIER ANALYZER, TFA and HARMONIC ANALYZER may be purchased together for a combined price of \$44.95 (three cassettes) and \$56.95 (three diskettes).

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```
Listing 4 continued:
                             0400
                                             RNZ
3064 CO
                                             MVI A, 1
3065 3E 01
                             0410
                                                              : RESET POSITION
                                             STA POS
3067 32 C2 30
                             0420
                             0430
                                             PUSH H
306A E5
                             0440
                                             LHLD DADD
306B 2A CO 30
306E 23
                             0442
                                             INX H
                                                              ; UPDATE BYTE ADDRESS
                                             SHLD DADD
                             0444
306F 22 CO 30
                                             POP H
3072 E1
                             0450
3073 C9
                             0460
                                             RET
3074
                             4000 *THE DECODE TABLE HAS THE FOLLOWING FORMAT:
3074
                             4010 *THE TABLE VALUE IS THE INCREMENT NECESSARY TO GET THE
3074
                              4020 *NEXT 0-1 PAIR AS THE PROGRAM STEPS THROUGH THE DATA
                             4030 *THE TABLE VALU JUST PRECEDING A CHARACTER HAS A TAG
4040 *SET IN BIT 7, IN ADDITION TO THE INCREMENT, TO INDICATE
4050 *THAT THE NEXT VALUE IS A CHARACTER.
3074
3074
3074
                                                              ;0
                              5000 XTAB:
                                             DB 42
3074 2A
                                                              ;1
3075 01
                              5010
                                             DB 1
                                                                  1
                                                              23,4
3076 02
                              5020
                                             DB 2
                                                                  0
                                                                  1
                                             DB 8
3077 08
                              5030
                                             DB 130
                                                                  0
3078 82
                              5040
                                                              ;5
                                                                  1
3079 02
                              5050
                                             DB 2
                                             I'B 'E'
                                                              ;6
                              5060
307A 45
                                             DB 130
                                                                  0
307B 82
                              5070
                                                              ;8
307C 82
                              5080
                                             DB 130
                                                                  1
                                                              ;9
                                             DB 'I'
307D 49
                              5090
                                                              ;10
                                             DB 'R'
307E 52
                              5100
                                                              ;11
                                             DB 6
DB 1
307F 06
                             5102
                              5104
                                                              ;12
3080 01
                                                                  1
                              5106
                                             DB 130
3081 82
                                                              ;13
                                                                  0
                                                              ;14
3082 82
                              5108
                                             DB 130
                                                              ;15
                              5110
                                             DB 'O'
3083 4F
                                                              ;16
                              5120
                                             DB 'A'
3084 41
                                                              ;17
3085 82
                              5130
                                             DB 130
                                                              ;18
                              5140
                                             DB 2
3086 02
3087 4E
                              5150
                                             DB 'N'
                                                              ;20 0
3088 03
                              5160
                                             DB 3
                                             DB 129
                                                              ;21 1
3089 81
                              5170
                                                              ;22
308A 44
                             5180
                                             DB 'D'
                                             DB 3
                                                              ;23 0
308B 03
                              5190
                                             DB 129
                                                              ;24
                              5200
308C
     81
                                                                  1
                                             DB 'P'
308D 50
                              5210
                                             DB 3
                                                              ;26
308E 03
                              5220
                                                              27 1
28
                                             DB 129
                              5230
308F 81
                                             DB 'V'
3090 56
                              5240
                                             DB 2
DB 5
3091 02
                                                              ;29
                             5250
                                                              30 1
31 0
32 1
33
3092 05
                              5260
                                             DB 130
3093 82
                             5270
                                             DB 130
LB 'J'
3094 82
                              5280
3095 4A
                              5290
3096 58
                                             DB 'X'
                                                              ;34
                             5300
                                                              ;35 0
3097 03
                                             DB 3
                             5310
                                             DB 129
                                                             ;36
;37
;38
3098 81
                             5320
                                                                  1
                                             DB 'K'
3099 4B
                             5330
309A 82
                                             DB 130
                             5340
                                                              ;39 1
309B 82
                             5350
                                             DB 130
                                                              ;40
309C 5A
                                             DB 'Z'
                              5360
                                                              ;41
309D 51
                             5370
                                             DB 'Q'
                                                              ;42
309E 02
                             5380
                                             DB 2
                                                                  0
309F 0E
                             5390
                                             DB 14
                                                              ;43
                                                                  1
                                             DB 3
                                                              :44
30A0 03
                             5400
                                                                  0
                                                              ;45
30A1 81
                             5410
                                             DB 129
                                                                  1
30A2 54
                                             DB 'T'
                                                              ;46
                             5420
                                            DB 2
DB 5
                                                              ;47
30A3 02
                             5430
                                                                  0
30A4 05
                                                              ;48
                              5440
                                                                  1
30A5 82
                                             DB 130
                                                              ;49 0
                             5450
                                                              ;50
30A6 82
                             5460
                                             DB 130
                                                                  1
                                                              ;51
30A7 59
                              5470
                                             DB 'Y'
                                                              ;52
30A8 47
                             5480
                                            DB 'G'
30A9 82
                              5490
                                             DB 130
                                                              53
                                                             ;54
30AA 82
                              5500
                                             DB 130
30AB 55
                              5510
                                             DB 'U'
                                                              ;56
30AC 4D
                                                'M'
```

5520

DB

Listing 4 continued on page 244

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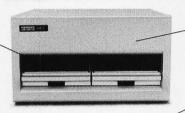


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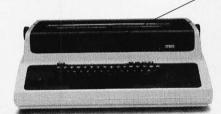
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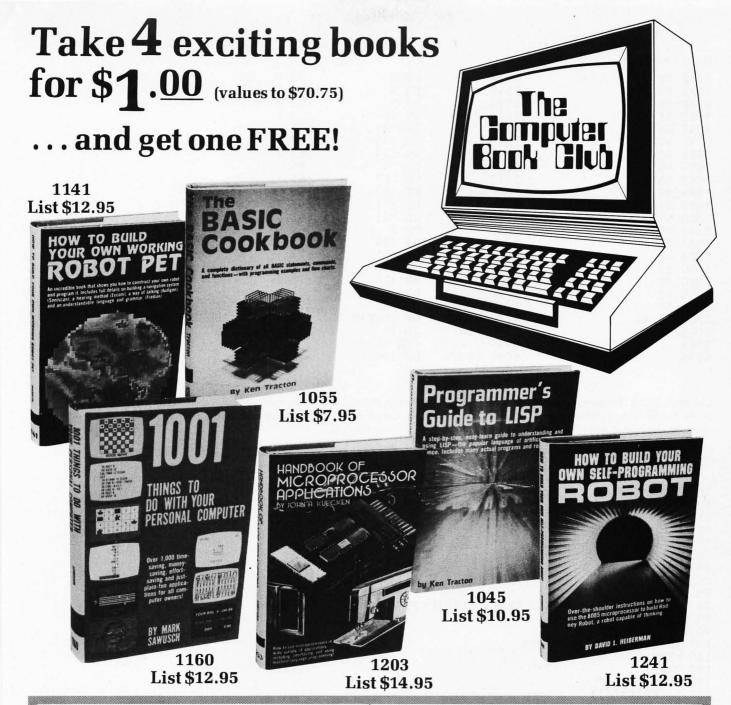
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```
Listing 4 continued:
                                                           ;57 0
                                           DB 2
30AD 02
                            5530
                                                           ;58 1
                            5540
                                           DB 8
30AE 08
                                                           ;59 0
30AF 03
                             5550
                                           DB 3
                            5560
                                           DB 129
                                                           ;60 1
30B0 81
                                                           ;61
                            5570
                                           DB 'H'
30B1 48
                                                           ;62 0
30B2 82
                             5580
                                           DB 130
30B3 82
                             5590
                                           DB 130
                                                           ;63 1
                                                           ;64
                                           DB 'C'
                            5600
30B4 43
                                                           ;65
                             5610
                                           DB 'F'
30B5 46
                                                           ;66
                                                               0
30B6 82
                             5620
                                           DB 130
                                                           ;67 1
                             5630
                                           DB 2
30B7 02
                                                           ;68
                                           DB 'S'
30B8 53
                             5640
                                                           ;69 0
                                           DB 3
30B9 03
                             5650
                                                           ;70 1
                                           DB 129
30BA 81
                            5660
                                                           ;71
                                           DB 'L'
30BB 4C
                            5670
                                                           ;72
                                           DB 130
30BC 82
                             5680
                                                           ; 73
                                           DB 130
                                                                1
30BD 82
                             5690
                                                           ;74
                                           DB 'B'
30BE 42
                             5700
                                                           :75
                                           DB 'W'
                             5710
30BF 57
                                                           NEXT DATA ADDRESS
                             5720 DADD:
                                           DW DBUF+2
30C0 02 41
                                           DS 1
                             5990 POS:
                                                           BIT POSITION
30C2
30C3
                             5999
                                           ORG 4100H
4100
                             6000 DBUF:
                                           DS 1000
```

Listing 5: BASIC frequency-analysis program FREQ. Written in Microsoft BASIC, this program receives text entered by the user and prints the frequency distribution of all letters and symbols. One symbol that does not appear by itself in a line of text is defined as marking the end of text; the symbol, defined in line 100, is presently "%".

LIST FREQ (FREQUENCY ANALYSIS PROGRAM)

```
10 CLEAR 3000
12 D=45
15 S=0
 20 DIM B$(2550)
30 DIM C(D)
40 DIM L$ (D)
50 FOR N=0 0 TO D
60 L$(N)="%"
70 NEXT N
75 PRINT "ENTER ANALYSIS TEXT, TERMINATE WITH %"
80 FOR N=0 TO 10
90 IMPUT B$(N)
100 IF B$(N)=""%" GOTO 120
110 NEXT N
120 F=N-1
125 FORN=0 TO F
130 L=LEN(B$(N))
140 FOR K= 1 TO L
150 A$=MID$(B$(N),K,1)
160 FOR J=0 TO D
170 IF L$(J)=A$ GOTO 220
180 NEXT J
190 L$(S) = A$
200 C(S)=C(S)+1
205 T=T+1
210 S=S+1
215 GOTO 230
220 C(J) = C(J) + 1
225 T=T+1
230 NEXT K
240 NEXT N
245 M=1
250 FOR K=1 TO S-2
255 FOR N=1 TO S-M
260 IF C(N-1)c=C(N) GOTO 274
262 T$=L$ (N-1)
264 U=C (N-1)
266 L$(N-1)=L$(N)
268 \text{ C(N-1)=C(N)}
```



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```
Listing 5 continued:
270 L$(N)=T$
272 C(N)=U
274 NEXT N
276 M=M+1
278 NEXT K
291 PRINT "LETTER FRECUENCY ANALYSIS"
    PRINT
           "LETTER", "COUNT", "PROBABILITY"
293 PRINT
294 PRINT
295
    PRINT
300 FOR N= 0 TO D
210 PRINT L$(N),C(N),C(N)/T
320 NEXT N
OK
```

Text continued from page 226:

is uniquely dependent upon the code being used. However, the basic structure and program can be used with any Huffman code.

There are three parts to the table structure: the index values that allow the program to step through the appropriate number of table entries (ie: tree branches) as the data-stream bit values are serially examined; the decoded character that results from the search; and a flag to indicate to the program that the next table entry found is a character and not an index value. The index values are always in pairs, with separate index values for a 1 or a 0 bit-stream value. Therefore, as the program scans through the table at each pair of index values, one or the other is selected, depending upon whether the bit in the

data stream is a 1 or a 0.

The table-scanning process consists of adding the data bit to the current table address. This gives a new address whose contents, an index value, is added to the *address* of the index value itself. This new table address is the address of the next node in the tree of figure 2.

This process continues until a flag is detected, indicating that the next entry is the desired letter. This test is performed each time an index-value address has been computed. The flag is the most significant bit in the table entry. The remaining 7 bits are interpreted as an ASCII character if the flag is on (logical 1) or as an index value if the flag is off (logical 0). This limits the index value to 127, the maximum distance in the table that can be skipped when processing 1 data bit. To help explain this process, a portion of the table is shown in figure 3.

In the Huffman code used in this program, the letter "I" is 1010. The decoding program identifies the corresponding letter by using the data bit stream and the decoding table previously described. The first data bit is added to the table address, TAB, giving a new address, TAB+1.

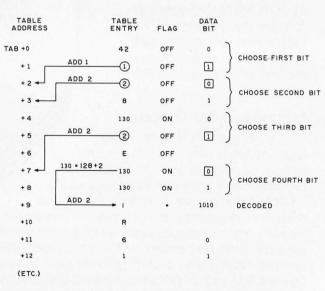


Figure 3: Use of the binary tree tables in programs EXP1 and EXP2. This annotated table interprets the first 13 bytes of the lookup table in both the code-expansion routines. It corresponds to the part of the binary tree in figure 2 that leads to the letters E, I, and R. This figure shows the process by which 1010 is decoded as the letter I.



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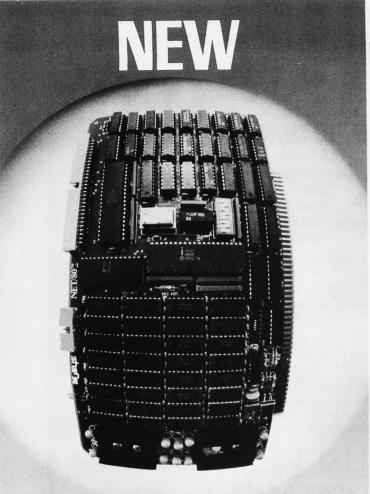


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The index value here, a 1, is added to the previous result, giving TAB+2. The first bit has now been processed.

Beginning on the second bit, 0 is added to the previous result and the new index value pointed to is 2. This is added to the previous result, giving a new address of TAB+4.

The second bit has now been processed. The next data bit, a 1, is added to the previous result, giving the address TAB+5. Adding the index value at this location, a 2, gives the new address, TAB+7. The third bit has now been processed.

Adding the last data bit, a 0, gives the entry 130. The fact that this value is greater than 128 proves that it is really an index value of 2 with the flag bit set; 130 = 128 +2. This tells the user that the next entry, two locations further, is the desired character. Adding the index value of 2 points you to the letter "I". Since a letter was found, the process is repeated from the beginning, continuing with the next bit in the data stream (providing that the supply of data has not been exhausted).

Shorter codes are used for the more frequently occurring data elements, and longer codes are used for less frequently occurring data elements.

COMP2 Description

The COMP2 program, given in listing 3, is similar to COMP1 except for one significant difference—the serial bit stream that results from the encoding process is packed and stored 8 bits to the byte. This provides true compression and is useful when the compressed file is stored in main memory or when the mass-storage device requires an 8-bit word. An interesting occurrence in using a compression scheme like this is that a low degree of data encryption occurs automatically when the bit stream is broken into 8-bit bytes. Referring back to the example where the word "compression" was represented by 47 bits, you can see that the 8-bit bytes look like the following:

(Binary)	(Hexadecimal)	(ASCII Meaning)
01000111	47	G
00001111	OF	SI (Control character)
01011011	5B	Left bracket
10001100	8C	Not defined in 7-bit ASCII
11010101	D5	Not defined in 7-bit ASCII
1101100	D(?)	Insufficient data

If someone looked at this data, it would not be immediately obvious that this is the word "compression". Some knowledge about the processing method or some effort in decoding it would be necessary to retrieve the original word.

EXP2 Description

The EXP2 program, given in listing 4, is similar to EXP1 except that it expects to find the data to be decoded in a packed form of 8-bit bytes. It works in conjunction with COMP2. As in EXP1, the decoded data is sent to some sort of terminal device. Any other destination could be used with a slight code change.

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Listing 6: Listing of the execution of program FREQ (listing 5). This listing is the result of running the FREQ program, using eight lines of BASIC code as the text to be analyzed.

O F		FREQUENCY ANALYSIS PROGRAM
		ANALYSIS TEXT, TERMINATE WITH % f=n-1"
?	"125	forn=0 to f"
?	"130	1=len(b\$(n))"
?	"140	for k= 1 to 1"
?	"150	a\$=mid\$(b\$(n),k,1)"
?	"160	for j=0 to d"
?	"170	if 1\$(j)=a\$ goto 220"
?	"180	next j"
?	9	

LETTER FRECUENCY ANALYSIS

LETTER	COUNT	PROB AB ILITY
34M67G8X5EBKAID RJ2LT()FN\$=001	1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2	7. 75194E- 03 1. 55039E- 02 1.
1	11 21	8.52713E-02 .162791

FREO Description

To aid in doing frequency analysis, a small program, FREQ, was written in Microsoft BASIC. (See listing 5.) This program counts the occurrence of symbols (letters, spaces, punctuation marks, etc) that have been entered

Line	Operation Performed	
10	Assign string space.	
12	Maximum number of unique symbols expected.	
15	Number of unique symbols entered.	
20	Text working buffer.	
30	Symbol count array.	
40	Symbol array.	
50 thru 110	Entry of text to be analyzed.	
80	Loop control for number of lines (may be increased).	
120	F is number of text lines entered.	
125 thru 180	Input line is transferred to text buffer.	
190 thru 240	Count number of each type of symbol; T is total count; C is count of corresponding symbol in symbol array.	
245 thru 278	Sort symbols by count in ascending order.	
291 thru 320	Computer probability and output results.	
Table 3: Operat	ions performed by lines of code in the	

and prints the frequency analysis. In order to include spaces in the count, the input array should be initialized to be filled with a symbol not occurring by itself in the text stream. The same symbol can be used to terminate the text-entry operation: I used a percent sign (%).

BASIC program FREQ of listing 5.

The size of the text block to be analyzed is limited only by available memory. To get a reasonably accurate analysis, the text block should be more than several hundred characters and be representative of the entire text. It is not necessary to do a frequency analysis every time a code is constructed. However, the closer the code lengths correspond to the frequency of occurrence, the more efficient the resulting compression will be.

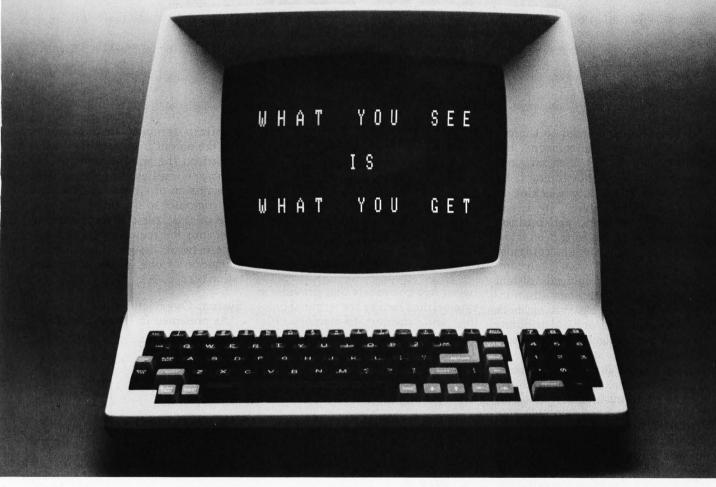
A sample run of FREQ is shown in listing 6 with the text input being part of the program itself. By comparing this output with the figures of table 1, you can see how the letter frequency for a BASIC source program compares to that of plain English text.

Finally, since there are no remarks in the FREQ program, the information in table 3 will help you understand the program. ■

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This article describes a specific implementation of a connection be-

About the Author

Mike Wingfield graduated from the University of California at Los Angeles in 1972 with a PhD in computer science. Presently, he is working for the computer consulting firm of Bolt, Beranek, and Newman in Cambridge, Massachusetts, where his specialty is the design and implementation of intercomputer communication software. His hobbies include gardening and experimentation with 6800- and 6809-based microcomputers.

The power of a computer is greatly enhanced when it can communicate with geographically distant computers

tween two computers that provides a symmetrical facility for terminal linking and memory-to-memory file

transfers. Terminal linking implies that the output from each terminal is echoed on the remote terminal. File transfer implies the error-free transmission of a block of data from one computer to the other. The purpose of this article is to provide insight into the requirements of large-scale network design through an examination of one specific implementation.

System Overview

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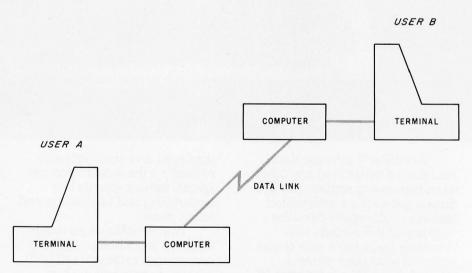
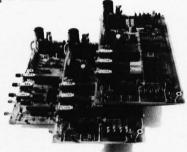


Figure 1: Typical data-link system configuration. Although the connection between the terminal and the computer is hardwired (ie: a direct electrical connection), the data link between computers (bridging a large distance) is usually accomplished via radio or telephone link.

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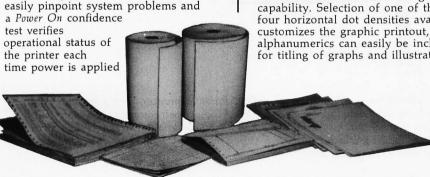
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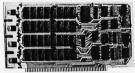


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hardware configuration of each computer—in this case, a 6800-based system. Two ACIAs (asynchronous communications interface adapters) provide the necessary interfaces to the terminal and to the line. The software involved occupies approximately 700 bytes of memory.

The user interface can be defined as the view the user has of his computer. The interface to the data-link software was designed to be as simple as possible (to reduce the amount of software), and yet provide the user with two capabilities:

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- Initiation of a file transfer from one

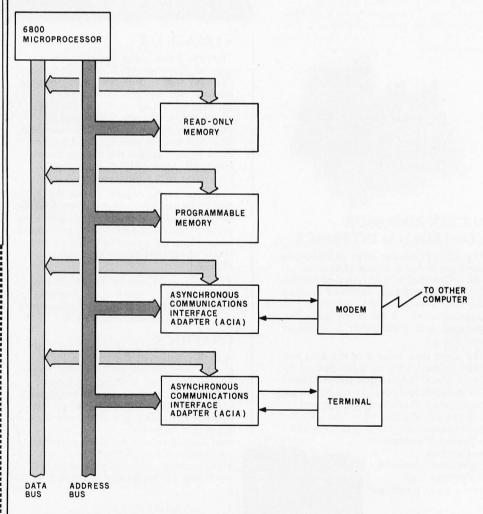


Figure 2: Hardware configuration of a 6800-based computer. The computer communicates across the data link by means of the ACIA, which converts the 8-bit bytes of information to a continuous (serial) stream of bits. This serial bit stream is transmitted by use of the modem, which translates between the binary signal and a signal that can be carried across telephone lines.

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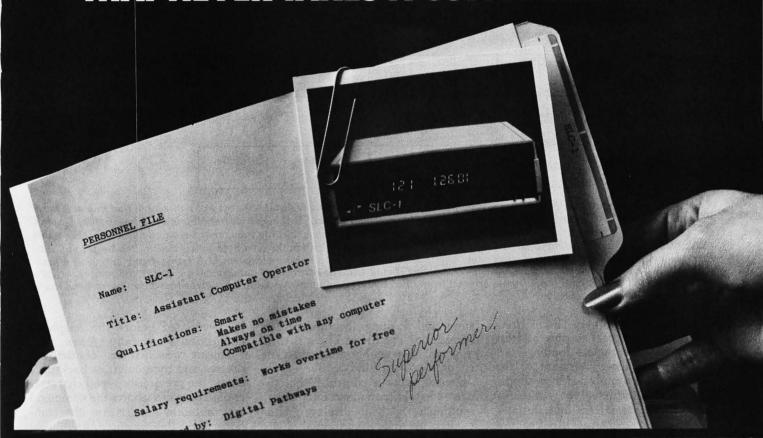
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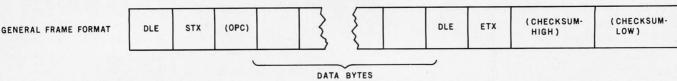


Figure 3: Frame format for data transmission. A frame is information that will be transmitted across the data link as a unit and checked for accuracy upon receipt. For the purposes of transmission accuracy, the data is preceded by a header and followed by a trailer. DLE and STX are both 1-byte ASCII characters. (OPC) stands for opcode, which is a 1-byte quantity that tells the receiver what kind of data follows. A running 2-byte total of the data bytes is kept. This is deposited as a checksum, high byte first, and is used by the receiving computer as a check against transmission errors.

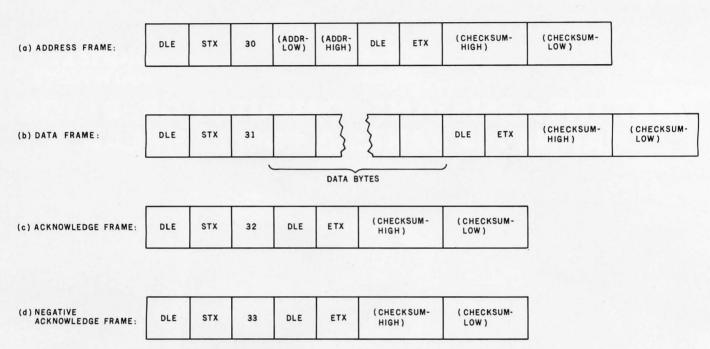


Figure 4: Frame formats for different types of data. The third byte in each frame dictates the type of data sent in that frame. A hexadecimal 30 means that the current frame contains a 2-byte hexadecimal address, sent high byte first: this is an address frame, with format as illustrated in figure 4a. A hexadecimal 31 denotes a data frame, which is the only frame that has a variable length. (See figure 4b.) Because the end of the data is marked by a DLE ETX sequence, a DLE within the data byte area is transmitted twice to indicate that it is data, rather than the end of valid data. A hexadecimal 32 denotes an acknowledge or ACK frame (figure 4c), while a hexadecimal 33 denotes a negative acknowledge or NAK frame (figure 4d). The address and data frames are sent to the computer that is receiving data. The ACK and NAK frames are sent from the receiving computer to acknowledge error-free or faulty transmission of the previous frame, respectively.

computer to the other. This is done by specifying a local starting address of the file, the remote loading-start address, and the byte count of the file. This is accomplished by a simple command interpreter that asks for these three parameters and initiates the transfer. Data blocks are transmitted by one computer, and their reception acknowledged by the other. This is the file-transfer mode of the software.

The following information outlines the sequence of events leading to the transfer of a file between computers. User A dials up user B over the telephone and both computers are connected via modems. (See figure 1.) User B tells user A, via the link, the

name and loading location of the desired file. The file can be a BASIC program, an assembly program, a letter, or any other kind of file.

User A types a control-F that initiates the local command interpreter, resulting in "S:" being displayed. User A keys in four hexadecimal digits (representing the source address) and a carriage return. The command interpreter types "D:" and waits for four more hexadecimal characters and a carriage return (representing the destination address).

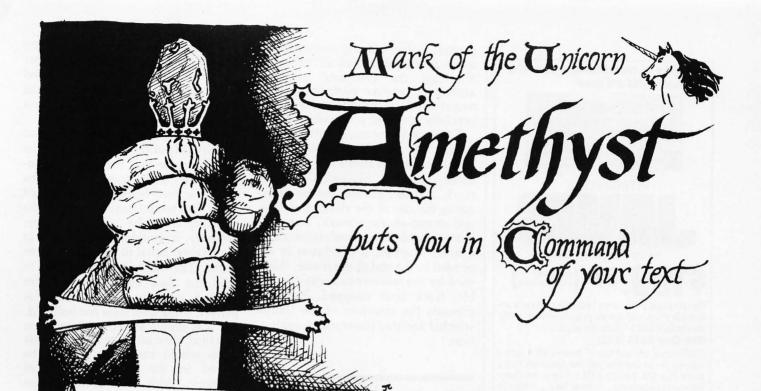
Finally, a "#:" directs user A to type in the byte count and a carriage return; this begins the file transfer. When the transfer is complete, user A's computer returns to the linking mode. Further file transfers can then

be negotiated before the telephone connection is manually broken.

During specification of the addresses and byte count, a backspace erases the previously typed character and a control-X aborts the command interpretation and returns the computer to the linking mode. Any illegal hexadecimal characters typed are ignored and the terminal bell is sounded for each occurrence.

Communication Protocol

To insure correct interpretation of a sequential stream of bytes, a communication protocol that imposes meaning on the data stream must be specified. Computer protocols, like human protocols, are those modes of behavior agreed upon between



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parties. Bridge-bidding sequences are an example of a human protocol, although the complete protocol agreement between partners must be negotiated. Computers require precisely specified protocols.

To encode meaning into a data stream, the concept of a frame must be introduced. A frame is a stream of bytes with a beginning-of-frame mark, a coded portion (which determines the use of the data), the data, and an end-of-frame mark. To enable more reliable communications along a noisy channel, a checksum is appended to the end of the frame; this is used by the receiver to verify that no bits have been dropped. Figure 3 presents the structure of the frames selected for this file-transfer applica-

Computer protocols, like human protocols, are those modes of behavior agreed upon between parties.

Since each byte in a stream can assume any one of 256 values, a special technique is used to denote the beginning and ending of a frame. One particular byte is selected to be the data-link escape (DLE), to signify that the next byte is to be interpreted as either start of frame (STX) or end of frame (ETX). The receiver, when seeing a DLE and a STX in series, knows that a frame has begun. When the DLE ETX pair is received, it knows that the end of frame has been reached and that the next 2 bytes contain the checksum. To preclude the appearance of a DLE STX or DLE ETX pair within the data portion of the frame, all DLEs in a data frame are doubled-that is, transmitted as DLE DLE. The receiver, seeing two sequential DLE bytes, simply discards one of them to restore the frame to its original length.

The byte following the DLE STX is assigned the function of an operation code (opc) that is used to give meaning to the data portion of the frame. Four types of frames are defined: an address frame (hexadecimal 30), a data frame (hexadecimal 31), an acknowledge frame (hexadecimal 32),

and a negative acknowledge frame (hexadecimal 33). These four frames represent the minimum set required to successfully get a file transferred from one computer to another in a simple, yet reliable fashion.

One design possibility not used here would put the address field in the data frame so that the start-load address for each frame would be available just before its associated data. This would have eliminated the necessity for the address frame; however, it would require a buffer in the receiver equal to the length of the frame. The buffer would be used to hold the data until the checksum verified that the received data is perfect. If the data were not buffered, but was simply stored at the address specified, then an error in the address bytes would cause the data to be stored in the wrong portion of memory. With a separate address frame, the address will be verified as correct before the data arrives so that no receive buffering is required.

Following receipt of the address or data frame, the receiver returns either an acknowledge (ACK) or a negative acknowledge (NAK) frame, thus indicating whether the frame received is perfect. The sender uses this information to decide whether or not to retransmit the frame. Thus, both computers must communicate to get the whole file transferred without

Figure 4 illustrates the structure of each of the four types of frames. Data bytes corresponding to the code for DLE are doubled only in the data frame, which has variable length. This is unnecessary in the other three frames because they have a predefined length.

The checksum is simply a 16-bit sum of all the bytes in the frame (except the first DLE and the trailing ETX). This provides an undetected bit-error rate which is adequate for this application.

The frame structure is used only in file-transfer mode; in linking mode, each character is sent immediately; no error checking is considered to be

necessary.

The lowest level of protocol involves the hardware interface between the two computers. In this application, the two computers are connected over an asynchronous bitserial channel. This technique was selected for several reasons. A serial

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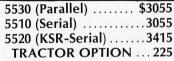
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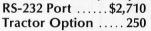
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six	fifty	80hertz tone	flow	less	over	star	ĥ	У
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nine	eighty	80ms silence	go	low	please	than	k	
ten	ninety	160ms silence	gram	lower	plus	the	ï	
eleven	hundred	320ms silence	great	mark	point	time	m	
twelve	thousand	centi	greater	meter	pound	try	n	
thirteen	million	check	have	mile	pulses	up	0	
fourteen	zero	comma	high	milli	rate	volt		
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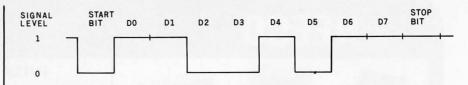


Figure 5: Serial transmission of data. When transmitting data between two computers on an asynchronous serial line, the data is transmitted 1 bit at a time with each byte of data (8 bits) framed by a start bit and a stop bit; a parity bit usually comes between the last data bit (D_7) and the stop bit but is omitted in this application due to the error checking already provided. Here, the byte being transmitted is binary 11010011 (read from right to left).

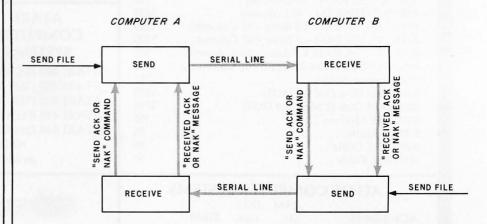


Figure 6: The interconnection of send and receive software modules. When computer A sends a data frame to computer B, the receive module of computer B tells its send module to transmit an ACK frame (if the data agrees with the checksum) or a NAK frame (if it does not). This acknowledge frame is received by computer A, which then informs its send module to transmit new data, or retransmit the previous frame, as necessary.

channel uses few wires when a direct connection is possible. For longer distances, the link can be made by a telephone line and standard modems. Also, there are integrated circuits interfacing directly to the microprocessor that can handle this format very well. Figure 5 demonstrates how 8-bit bytes are transmitted along with their start and stop bits. To improve efficiency, no parity bit is used since the checksum provides error control.

Software Description

The software is organized into three cooperating modules: the send routine, the receive routine, and the command interpreter. The send and receive modules are used mainly for file transfer. The conceptual connection of these two software modules in both computers is detailed in figure 6. The send routine of computer A sends to the receive routine in computer B, and vice versa.

When the send module in A sends a frame, the receive module in B

verifies the checksum and tells the send module in B to send either an ACK or a NAK back to A. The send module in B sends the ACK or NAK to A's receive module, which then informs A's send module that an ACK or a NAK was received. Thus, two flags are necessary for communicating between the send and receive modules: one commanding "send ACK or NAK," and the other stating "received ACK or NAK." A "send file" flag to the send module of A initiates the file transfer.

Note the symmetry. Because the send and receive sections in each computer are independent, and because they communicate by flags, the send output can be fed directly into the receive input in the same computer for test purposes during debugging. Files can be moved from one place in memory to another within the same machine, simulating the actions of two coupled machines.

The third module of code is the command interpreter, which is used to specify the source starting address,

Text continued on page 266

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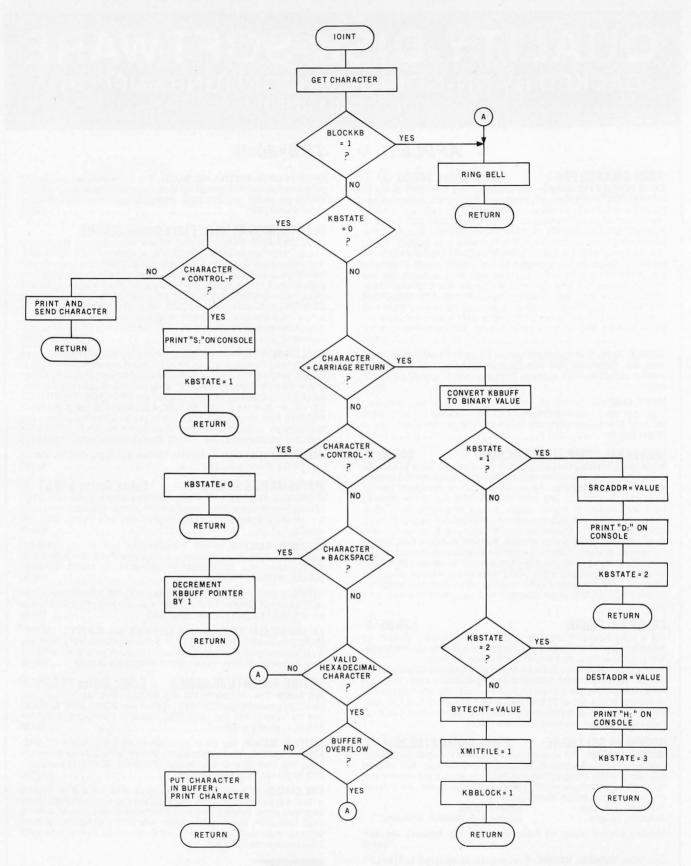


Figure 7: Flowchart for the command interpreter, IOInt. This routine gathers the information necessary to initiate the transfer of a given block of information between computers. An interrupt from the keyboard causes this routine to be executed (from the beginning) every time a key is pressed. The value of KBSTATE (keyboard state) causes the routine to ask for the starting address of the block to be sent (with the prompt "S:"). This is followed by a request for the destination address for the first byte (prompted with "D:"), and the number of bytes to be transferred (prompted with "#:"). Once this information has been given, the routine disables the keyboard from further input (KBBLOCK=1) and sets a flag that tells the software send module to begin sending the block of data (XMITFILE=1).

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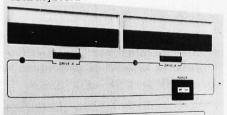
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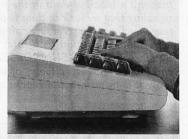
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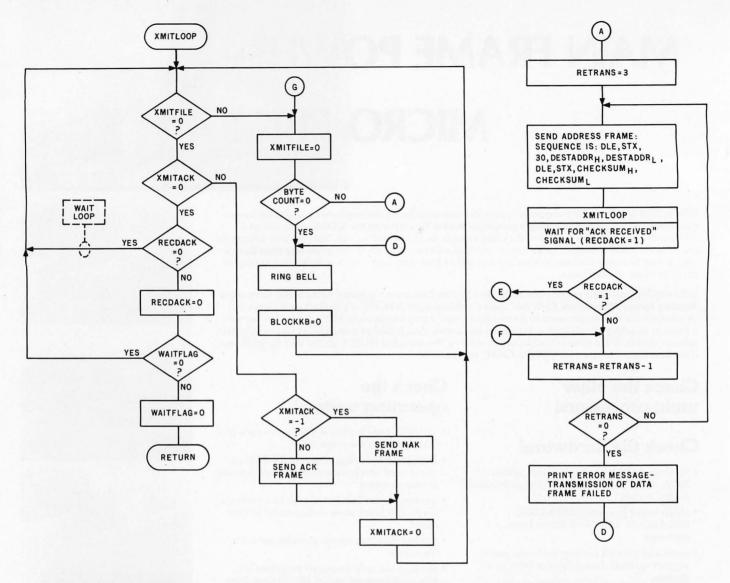


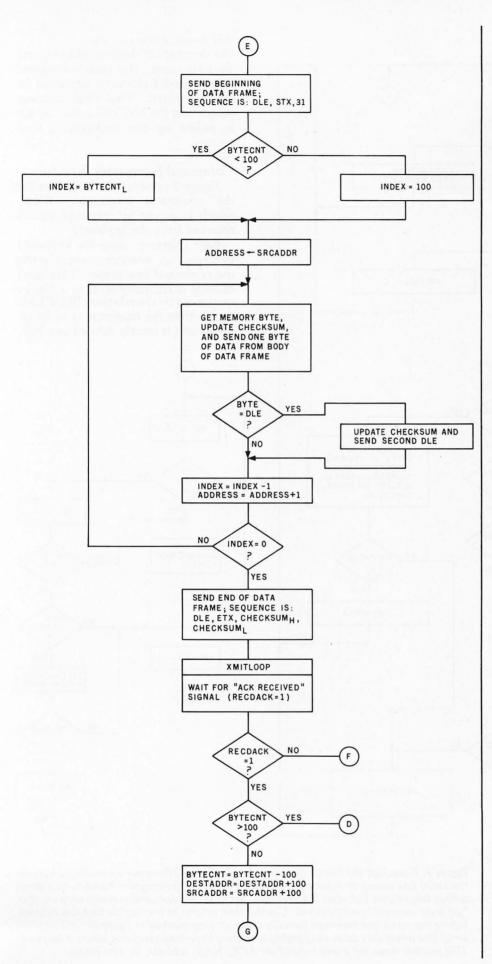
Figure 8: Flowchart for the send module. This routine, when activated by the condition XMITFILE=1, causes the computer to transmit a block of data in the form of an address frame, followed by a data frame. It waits in a loop until XMITFILE is set to 1, signaling that a block of data is ready to be transmitted. It then sends the address data frames, waiting after each for an ACK frame response from the receiving computer. If either frame is received imperfectly, the process begins again with the address frame. Software limits repetition to a total of three tries. All numbers used in this figure are hexadecimal. Also, the variables ADDRESS, BYTECNT, CHECKSUM, DESTADDR, INDEX, and SRCADDR are all 2-byte variables. The subscripts H and L refer to the high and low bytes, respectively, of a 2-byte variable. If the block to be transmitted is more than decimal 256 (hexadecimal 100) bytes long, it is transmitted in blocks of 256 bytes.

On Flowcharting Interrupt-Driven Routines

The perceptive reader may notice that the flowchart of figure 9 (on page 266) does not have a return or end block. Although it may not be immediately obvious, the same is true of the flowchart in figure 8. (The one return block that does exist is used only when the XmitLoop routine is returning from calling itself.) The reason for this and other seeming omissions has to do with the function of interrupts in the data-link routines.

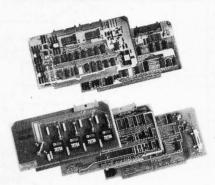
When the data-link software (see listing 1) is running, it is usually in the XmitLoop routine, repeating the wait loop marked in the flowchart of XmitLoop. (See figure 8.) If an interrupt comes from the keyboard, control transfers to the IOInt routine, flowcharted in figure 7, and returns to the routine that was executing before the interrupt.

If an interrupt comes from the serial line, control transfers to some location within the LineInput routine, but, instead of starting at the beginning of the routine (as is done with the IOInt routine), control transfers to the instruction directly after the "bsr GetByte" (branch to GetByte subroutine) instruction most previously executed. (See figure 9.) This can be accomplished because the GetByte subroutine stores the return address in the variable ACIAState; it is this address that is jumped to upon a serial line interrupt (see routine IOInt in listing 1).



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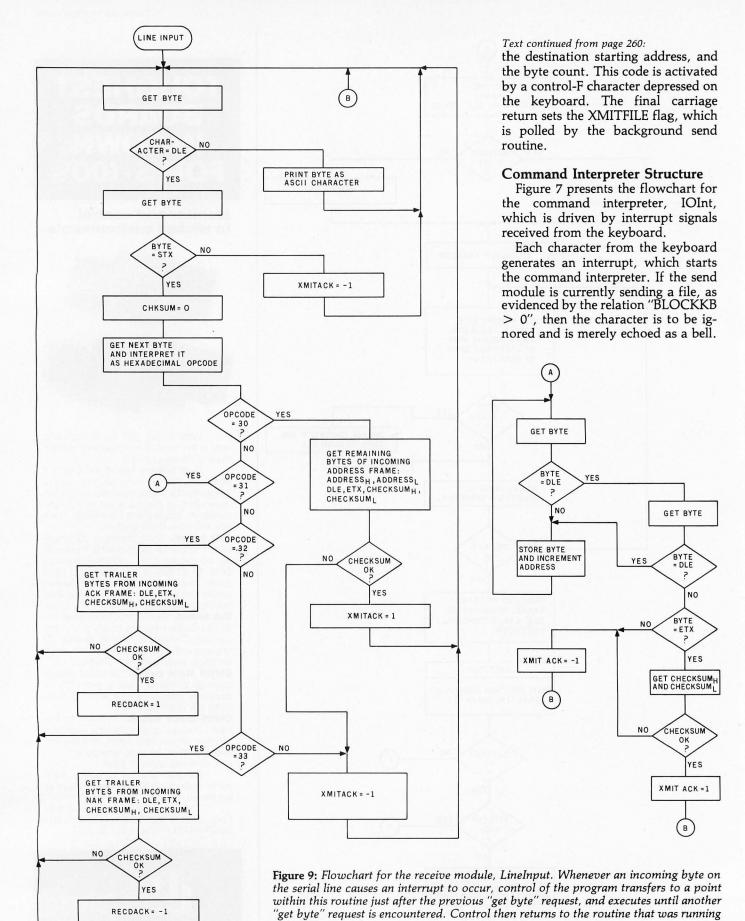
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before the serial line interrupt (usually the wait loop marked in figure 8) until another serial line interrupt causes the LineInput routine to resume execution where it stopped.

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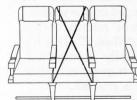
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The operation of the interpreter is a function of the state variable, KBSTATE. If the state is zero, the transparent mode case, the character is echoed locally and sent to the remote computer. Otherwise, the character is tested for being a carriage return (CR).

The carriage return causes the keyboard buffer (which collects address or byte-count hexadecimal characters) to be converted to a binary value. If the character is a control-X, the interpreter mode is aborted and KBSTATE is returned to zero.

If the character is a BS (backspace), the pointer into the keyboard buffer is decremented (after first checking for underflow). If none of the above is true, the character is checked for being a proper hexadecimal character and is then put in the keyboard buffer (after checking for overflow). The keyboard buffer holds as many as four hexadecimal characters, which is the largest buffer needed to specify a 16-bit address or a byte count.

The sequence of characters echoed on the terminal following the carriage return, as well as the location of the binary value, are dependent on the current state of the interpreter. After each carriage return, the state is incremented to ensure that the correct control path is executed for each of the three parameters collected. Finally, the last carriage return after the byte count specification sets the BLOCKKB flag and the XMITFILE flag. The BLOCKKB flag prevents any keyboard characters from appearing on the line during a file transfer. The XMITFILE flag tells the send module to begin sending the specified file.

Send Routine Structure

The send module, XmitLoop, is responsible for sending address, data, ACK, and NAK frames to the remote receive module. Figure 8 shows the flowchart for the program flow of the send routine. This routine operates in background mode, testing three flags to see if any work is pending. If the XMITACK flag is -1, a NAK frame is sent; if it is +1, an ACK frame is sent.

If the RECDACK flag is not zero, and the send routine is waiting for an ACK or a NAK, then a return is made

to the data transfer routine to complete the data or address frame transfer. (This will be explained in more detail later.) If the XMITFILE flag is non-zero, then file transfer begins.

As explained earlier, the address frame is sent first so that no buffering in the receiver is necessary in case of an address error. Once the address is correctly received and acknowledged, a data frame is sent. If the data frame is acknowledged, the next address and data frames are sent, and the process is repeated.

If a NAK frame is received, then the address frame received in error is retransmitted and verified before the data block is retransmitted. When sending either an address or a data frame, the send routine employs the same mechanism in waiting for an ACK or NAK. When the wait for an ACK or NAK signal is necessary, the send module XmitLoop calls itself by storing the return address on the stack and branching to the beginning of the routine. When the send routine finds that the RECDACK flag is set, control is returned to the proper location in the send routine via an RTS (return from subroutine) instruction. The RECDACK flag indicates whether a new frame should be sent or the old one retransmitted.

A retransmission index is maintained and decremented each time a frame retransmission is necessary, and no more than three retransmissions are allowed. (The number of retransmissions allowed is a parameter that is easily changed.) If more than three failures occur, an error message is typed on the sender's console and control returns to the transparent mode. When all of the file has been successfully transmitted, control returns to transparent mode and the keyboard is enabled.

In data frames, data bytes that happen to have the same hexadecimal value as the DLE code are doubled (repeated) so that a false end of frame is prevented; the receive routine drops the second DLE so that the data is received correctly. In the worst case, this has the effect of doubling the length of the frame.

Receive Routine Structure

The flowchart for the receive program, named LineInput, is shown in figure 9. This routine handles the in-

Text continued on page 286

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269

Listing 1: Software for data transfer between two 6800-based systems linked by a serial line. The software here consists primarily of a data-sending routine (labeled XmitLoop), a data-receiving routine (labeled Linelnput), and a command interpreter (labeled IOInt). All numbers preceded by a dollar sign (\$) are hexadecimal numbers. Also, references to '0, '1, '2, and '3 are actually to the characters "0", "1", "2", and "3". These characters, when represented in ASCII, have values of hexadecimal 30, 31, 32, and 33 and are referred to in text and in flowcharts as such. Flowcharts 7 thru 9 correspond to the code given in this listing.

0090	dle	equ	390	dle char	
0083	etx	equ	\$83	etx char	
0085	stx	equ	882	stx char	
3007	bel1	equ	7	bell cha	r
0018	*X	equ	\$18	control '	X
9996	*F		6	control I	
		equ		7/E-10E0/2-10(E) 1/2 EAU E/A //	
0008	bs	equ	8	backspace	
CONES	Cr	equ	<i>\$</i> d	carriage	return
M218	IOPtr	equ	518	T/O inte	rrupt vector
FORD	AciaCsr1	equ	\$ 1900	Acia to	terminal
F901	AciaDatal	equ	5 4 9 0 1		
F902	AciaCsr2	equ	\$ 1902	Acia to	modem
F973	AciaData2	equ	\$ 1903		
9959	SaveOpc	equ	\$50	place to	save opc
9051	AciaState	equ	\$51	state of	acia fsm
			\$54		ce address
0054	SrcAddr	equ			which are the second of the se
9956	DestAddr	equ	\$56	ftp dest	ination addr
0058	ByteCnt	equ	\$58	ftp byte	count
005B	The second secon		\$5b	Section 1. P. Commission	save number
	BinVal	equ			
9950	KbPtr	equ	\$5d	ptr into	
WASF	KbBuff	equ	\$5 f	4 char b	uffer
9862	KbEnd		\$62	end of b	uffor
		equ			
0063	ChkSum	equ	\$63	xmit che	cksum, recv side
2265	RecdChk	equ	\$65	recd che	cksum, recv side
006A	KbState	equ	\$6a	gtate of	kh handler
MM98	Recdack	equ	\$6 b	flag - r	
006C	XmitAck	equ	\$6c	flag - s	end ack
0260	XmitFile	equ	\$6d	flag - s	end file
	WaitFlag		16e		ait for ack/nack
MM6E		equ			
9. 6F	BlockKb	equ	56f	flag - h	locks kb activ
7775	SaveSum	equ	\$75	place to	save checksum
4977	XChkSum	equ	\$77	xmitted i	
0279	1 4 4 4 4 4				
	Address	equ	\$79	recv sto	re address
	Address	equ	\$ 14	recv sto	re address
	Address	eau	\$ 79	recv sto	re address
	Address	equ			re address
1000	Adoress	equ	ora	\$1000 \$1000	re address
			ora		re address
		* Entry (ora	51080	
			ora		re address
1000	86 03	* Entry	orq point 1da a	\$1000 #3	
1000	86 03 B7 F900	* Entry	orq point lda a sta a	#3 AciaCsr1	
1000 1000 1002 1005	86 03 B7 F900 B7 F902	* Entry	orq point lda a sta a sta a	#3 AciaCsr1 AciaCsr2	reset Acia's
1000	86 03 B7 F900	* Entry	orq point lda a sta a	#3 AciaCsr1	
1000 1000 1002 1005 1008	86 03 87 F900 87 F902 86 96	* Entry	orq point lda a sta a sta a lda a	#3 ActaCsr1 ActaCsr2 #896	reset Acia's
1000 1000 1002 1005 1008	86 03 B7 F900 B7 F902 86 96 B7 F900	* Entry	orq point lda a sta a sta a lda a sta a	#3 ActaCsr1 ActaCsr2 #596 ActaCsr1	reset Acia's
1000 1000 1002 1005 1008 100A	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902	* Entry	orq point lda a sta a lda a sta a sta a	#3 ActaCsr1 ActaCsr2 #\$96 ActaCsr1 ActaCsr2	reset Acia's /64,8 bits, interr
1000 1000 1002 1005 1008	86 03 B7 F900 B7 F902 86 96 B7 F900	* Entry	orq point lda a sta a sta a lda a sta a	#3 ActaCsr1 ActaCsr2 #596 ActaCsr1	reset Acia's
1000 1000 1002 1005 1008 100A 100D	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD	* Entry	orq point lda a sta a lda a sta a sta a	#3 ActaCsr1 ActaCsr2 #\$96 ActaCsr1 ActaCsr2	reset Acia's /64,8 bits, interr
1000 1000 1002 1005 1008 100A 100D 1010	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51	* Entry	orq point lda a sta a lda a sta a lda a sta a ldx stx	#3 AciaCsr1 AciaCsr2 #596 AciaCsr1 AciaCsr2 #InzAcia AciaState	reset Acia's /64,8 bits, interr
1000 1000 1002 1005 1008 100A 100D 1010 1013 1015	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 1102	* Entry	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx	#3 AciaCsr1 AciaCsr2 #596 AciaCsr1 AciaCsr2 #InzAcia AciaState #10Int	reset Acia's /64,8 bits, interr
1000 1000 1002 1005 1008 100A 100D 1010 1013 1015	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 1102 DF 18	* Entry	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx	#3 AciaCsr1 AciaCsr2 #596 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt	reset Aciars /64,8 bits, interr set up acia2 entry
1000 1000 1002 1005 1008 100A 100D 1010 1013 1015	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 1102	* Entry	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx	#3 AciaCsr1 AciaCsr2 #596 AciaCsr1 AciaCsr2 #InzAcia AciaState #10Int	reset Acia's /64,8 bits, interr
1000 1000 1002 1005 1008 100A 100D 1010 1013 1015 1018	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 1102 DF 18	* Entry	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx ldx	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr2 #InzAcia AciaState #IOInt IOPtr	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1000 1002 1005 1008 1000 1010 1013 1015 1018	86 03 B7 F900 B7 F902 86 96 B7 F900 CE 11CD DF 51 CE 1102 DF 18 86 06 CE 006A	* Entry (Start	orq point lda a sta a lda e sta a ldx stx ldx stx lda a ldx	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState	reset Aciars /64,8 bits, interr set up acia2 entry
1000 1000 1002 1005 1008 1000 1010 1013 1015 1016 1016	86 03 B7 F900 B7 F902 86 96 B7 F900 CE 11CD DF 51 CE 1102 DF 18 86 06 CE 006A	* Entry	orq point lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr2 #InzAcia AciaState #IOInt IOPtr	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1000 1002 1005 1008 1000 1010 1013 1015 1018	86 03 B7 F900 B7 F902 86 96 B7 F900 CE 11CD DF 51 CE 1102 DF 18 86 06 CE 006A	* Entry (Start	orq point lda a sta a lda e sta a ldx stx ldx stx lda a ldx	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1000 1002 1005 1008 1000 1010 1013 1015 1016 1016	86 03 B7 F900 B7 F902 86 96 B7 F900 CE 11CD DF 51 CE 1102 DF 18 86 06 CE 006A	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1002 1005 1008 100A 100D 1013 1015 1016 1017 1017 1022	86 03 B7 F900 B7 F902 86 96 B7 F900 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 000 08	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx lda a ldx clr inx dec a	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #KbState x	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1002 1005 1008 1000 1001 1013 1015 1016 1017 1022 1023	86 03 B7 F900 B7 F902 86 96 B7 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A 26 FA	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx ldx stx ldx stx ldx stx	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #10Int IOPtr #6 #KbState x inzloop	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1025	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 11M2 DF 18 86 006 66 000 67 000 68 000 60 000 60 0	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx ldx stx ldx stx	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags
1000 1002 1005 1008 1000 1001 1013 1015 1016 1017 1022 1023	86 03 B7 F900 B7 F902 86 96 B7 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A 26 FA	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx ldx stx ldx stx ldx stx	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #10Int IOPtr #6 #KbState x inzloop	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1028	86 03 B7 F900 B7 F902 86 96 B7 F900 B7 F902 CE 11CD DF 51 CE 11M2 DF 18 86 006 66 000 67 000 68 000 60 000 60 0	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx ldx stx ldx stx	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1023 1023	86 03 87 F900 87 F902 86 96 87 F900 87 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A CE 005F DF 5D	* Entry (Start	ord point lda a sta a lda a sta a ldx stx ldx stx ldx stx ldx clr inx dec a bne ldx stx nop	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1028	86 03 87 F900 87 F902 86 96 87 F900 B7 F902 CE 1100 DF 51 CE 1102 DF 18 86 006 66 000 67 0	* Entry (Start	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx	#3 AciaCsr1 AciaCsr2 #396 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1023 1023	86 03 87 F900 87 F902 86 96 87 F900 87 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A CE 005F DF 5D	* Entry Start	ord point	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff KbPtr	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr
1000 1002 1008 1008 1000 1013 1015 1016 1017 1023 1023 1023 1023	86 03 87 F900 87 F902 86 96 87 F900 87 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A CE 005F DF 5D	* Entry Start	ord point	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff KbPtr	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area
1000 1002 1008 1008 1000 1013 1013 1015 1016 1022 1022 1022 1022 1022 1022 1022	86 03 87 F900 87 F902 86 96 87 F900 87 F902 CE 11CD DF 51 CE 1102 DF 18 86 006 6F 00 08 4A CE 005F DF 5D	* Entry Start	ord point	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff KbPtr	reset Aciars /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr
1000 1002 1008 1008 1000 1013 1013 1015 1016 1017 1022 1022 1022 1022 1022 1022 1022	86 03 87 F900 87 F902 86 96 87 F900 CE 1100 DF 51 CE 1102 DF 18 CE 0006 008 44 CE 5D 008 44 CE 5D 011 011 012 013 014 015 016 017 017 017 017 017 017 017 017	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a ldx stx ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli	#3 AciaCsr1 AciaCsr2 #596 AciaCsr1 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 #KbState x inzloop #KbBuff KbPtr	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr
1000 1002 1008 1008 1000 1001 1013 1015 1016 1017 1022 1022 1022 1022 1022 1022 1022	86 03 87 F900 87 F902 86 96 87 F902 CE 1102 DF 1102 DF 1103 DF 106 006 008 44 FA CE 5D 011 011 011 011 012 013 014 015 016 017 017 017 017 017 017 017 017	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli und routin lda a bne	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #KbState x inzloop #KbBuff KbPtr	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr event entries xmit file event?
1000 1002 1008 1008 1000 1001 1001 1001	86 03 87 F900 87 F900 86 P6 00 87 F900 CE 1100 DF 1100 DF 1100 DF 1100 DF 1000 DF 1	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli und routin lda a bne ldx	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #KbState x inzloop #KbBuff KbPtr he = checks Xmitfile InzAddr #Nackfrm	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr event entries xmit file event? ptr to Nack frame
1000 1002 1008 1008 1000 1001 1013 1015 1016 1017 1022 1022 1022 1022 1022 1022 1022	86 03 87 F900 87 F902 86 96 87 F902 CE 1102 DF 1102 DF 1103 DF 106 006 008 44 FA CE 5D 011 011 011 011 012 013 014 015 016 017 017 017 017 017 017 017 017	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli und routin lda a bne	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #KbState x inzloop #KbBuff KbPtr	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr event entries xmit file event?
1000 1000 1000 1000 1000 1001 1001 100	86 03 87 F900 86 F900 87 F900 87 F900 DF 1100 DF 1100 DF 1100 DF 1100 DF 1000 000 000 000 000 000 000 000	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli ound routin lda a bne ldx lda a	#3 AciaCsr1 AciaCsr2 #596 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #6 KbState x inzloop #KbBuff KbPtr re = checks XmitFile InzAddr XmitAck	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr event entries xmit file event? ptr to Nack frame
1000 1002 1008 1008 1000 1001 1001 1001	86 03 87 F900 87 F900 86 P6 00 87 F900 CE 1100 DF 1100 DF 1100 DF 1100 DF 1000 DF 1	* Entry Start inzloop * Backgro	orq point lda a sta a lda a sta a lda a sta a ldx stx ldx stx lda a ldx clr inx dec a bne ldx stx nop cli und routin lda a bne ldx	#3 AciaCsr1 AciaCsr2 #\$96 AciaCsr2 #InzAcia AciaState #IOInt IOPtr #KbState x inzloop #KbBuff KbPtr he = checks Xmitfile InzAddr #Nackfrm	reset Acia's /64,8 bits, interr set up acia2 entry clear the flags start of area inz the buffer ptr event entries xmit file event? ptr to Nack frame

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```
Listing 1 continued:
1039
      27 F1
                                       XmitLoop
                            bea
      97 6B
                                       RecdAck
1038
                            sta a
                                                  clear the event
                                       WaitFlag
1030
      96 6E
                            1da a
193F
      27 FB
                            bea
                                       XmitLoop
      7F PPGE
1041
                            cir
                                       WaitFlag
                                                  clear the flag
1944
      17
                            tha
                                                  reg a is ack/nack flag
1045
      39
                            rts
                                                  return to waiting routine
                 * Routine for sending Ack/Nack frame
1046
      28 93
                GOACK
                            bm 1
                                       Skoldy
                                                  send nack?
                                       #AckFrm
1948
      CE 1260
                            1 dx
                                                  send ack!
1048
      C6 07
                Skpldx
                            1da b
                                       # 7
                                                  frame byte count
                                                  get byte
1040
      A6 00
                FrmLoop
                            1da a
104F
      BD 10EA
                            Jsr
                                       SendChar
                                                  send out
1952
      28
                            inx
1953
      5 A
                            dec b
1054
      26 F7
                                       FrmLoop
                            bne
1056
                                       Xmit Ack
      D7 6C
                            sta b
                                                  clear the event
1058
      20 02
                Fin4
                            bra
                                       XmitLoop
                 * Routine for sending Address frame
                                                  clear flag
                                       Xmitfile
105A
      7F 8060
                 InzAddr
                            clr
                                                  check for null
                            1dx
                                       ByteCnt
1050
      DE 58
                                       LastBlk
105F
      27 51
                            bea
                                                  retransmission index
                            1da b
                                       #3
1961
      C6 03
                            psh b
                                                  save it
                 GoAddr
1063
      37
                                       # 0
      C6 30
                            1da b
                                                  opcode byte
1864
                                       SendHdr
                                                  send dle, stx, opc
1066
      80 52
                            bsr
                                       DestAddr
                                                  send out addr bytes.
1968
      96 56
                            1da a
                                       UpdtChk
106A
      8D 73
                            bsr
                                       DestAddr+1
      96 57
                            1da a
146C
                                       UpdtChk
106E
      80 6F
                            bsr
                                                  send dle, etx, cc = wait
                                       Send11
1070
      80 59
                            bsr
                         is a wait for ack/nack here
                 * there
                            pul b
                                                  get retrans index
1072
      33
                                                  check ack/mack flag
      40
1073
                            tst
      2B 33
                                       RetryBlk
                                                  branch if ack
1074
                            bmf
                 * Routine for sending block of data
                Gofile
                                                  save retrans index
1976
      37
                            psh
                                       # " 1
      C6 31
                            1da b
                                                  opcode
1977
                                       SendHdr
                                                  send dle, stx, opc
      80 3F
                            bsr
1979
                            cir b
                                                  inz byte count index
127B
      SF
                                                  chk upper byte
                                       ByteCnt
107C
      96 58
                            1da a
                                       Skipld
                            bne
107E
      26 92
                                       ByteCnt+1 < 256 bytes left
1980
      06 59
                            1da b
                                       SrcAddr
      DF
                Skipl.d
                            1dx
1982
         54
                                                  save it
1084
      37
                SendBytes
                           psh b
                                                  get byte
1285
      A6 80
                            1da a
                                       ×
      33
                            pul b
                                                  restore
1087
                                       UpdtChk
                                                  undate checksum, send
1088
      80 55
                            bsr
                                                  check for dle
1284
      81
         97
                            cmp a
                                       #dle
                                       FinDoub
      56 95
1080
                            hne
108E
      80 4F
                            bsr
                                       UpdtChk
                                                  update checksum, send
                FinDoun
1090
      78
                            inx
                                                  check byte count
1091
      54
                            dec b
                                       SendBytes
      26 FØ
                            bne
1092
                                       SendT1
                                                  send die, etx, cc - wait
1094
      8D 35
                            bsr
                                     for ack/nack here
                   there
                         is a wait
                                                  get retrans index
1096
      33
                            pul b
                                                  check ack/nack flag
1097
      40
                            tst a
                                                  check for failure
                                       RetryBlk
1098
      28 aF
                            hm i
      96 58
                            1da a
                                       ByteCnt
                                                  check for done
1094
                                       LastBlk
1090
      27 14
                            bea
                                       ByteCnt
                                                  decrease by 256 bytes
109E
      7A 9958
                            dec
                                       DestAddr
                                                  increase by 256 bytes
      70 0056
                            inc
1 341
                                       SrcAddr
                                                  increase by 256 bytes
10A4
      7 C
         0.054
                            inc
                                       InzAddr
19A7
      24 B1
                            bra
                RetryBlk
                            dec h
1049
      5 A
                                       GoAddr
1 AAA
      26 B7
                            bne
1 MAC
                Frror
                            1dx
                                       #ErrorMsq print error msg
      CE 126E
      BD
                                       OutText
19AF
         1182
                            Jsr
```

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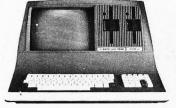
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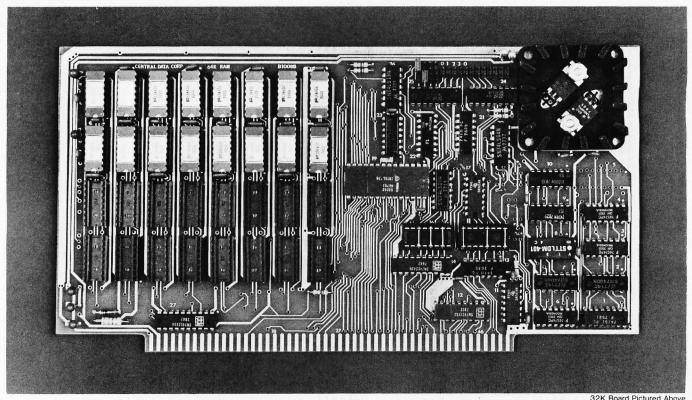
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```
Listing 1 continued:
1082
       86 97
                 LastBik
                            1da a
                                        #be11
                                                   ring the bell
1084
       80 41
                                        SendTerm
                                                   send bell to term
                            nsr
                                        BlockKb
1086
       D7 6F
                             sta b
                                                   unlock the kh
1988
       20 9E
                 Fin2
                            bra
                                        Fin4
                                                   end of file xfer
                 * Subroutine which
                                       sends out dle, stx, and inz checksum
10BA
       86 97
                 SendHdr
                             1da a
                                        #dle
                                                   dle char
                                        SendChar
1080
                             bsr
                                                   send die
       8D 2C
       AF
                             clr a
10BE
10BF
       97 77
                                        XChkSum
                             sta a
                                                    inz checksum
10C1
       97
          78
                             sta
                                        XChkSum+1
                                 a
                             1da a
                                        #stx
1003
       86
         82
                                        UpdtChk
1005
       8 D
          18
                             bsr
                                                   send stx
10C7
                             tha
       17
                                        UpdtChk
1008
       80 15
                             bsr
                                                   send opcode
10CA
       39
                             rts
                 * Subroutine which sends out dle, etx, ccl, cc2
                 * and sets up wait
                                       for ack/nack
10CB
       86 90
                 SendT1
                                        #dle
                            1da a
       97 6E
                                        waitflag
1200
                             sta a
                                                   indicate waiting ack/nack
                                        UpdtChk
1 OCF
       80 RE
                             bsm
                                                   send out die
1001
       86 83
                             1 da
                                        #etx
1003
                                        SendChar
                                                   send out etx
       80 15
                             bsr
                             1da
                                        XChkSum
       96 77
1005
                                                   send high hyte
                                        SendChar
1007
       80 11
                             bsr
1909
       96
          78
                             Ida
                                        XChkSum+1
10DB
                                        SendChar
                                                   send low byte
       80 00
                             bsr
       20 09
IDDD
                             bra
                                        Finz
                                                   go to idle loop
10DF
                 UpdtChk
                            nsh a
       36
                                        XChkSum+1
10ER
       98 78
                             add
                                        SKOH
10E2
       24 43
                             bcc
                                        XChkSum
10E4
       70 0077
                             inc
                                        XChkSum+1
19E7
       97 78
                 SKOH
                             sta a
10F9
       32
                             pul a
10EA
       37
                 SendChar
                             psh b
                                                    save it
       F6 F902
                                        AciaCsr2
10EB
                             1 da b
                                                   get status
       C4 32
10EE
                             and h
                                        #2
                                                    test for xmit ready
       27 F9
                                        SendChar+1
10F0
                             bea
10F2
                                        AciaData2
       87 F903
                             sta
                                 a
10F5
       33
                             pul
                                                    restore req
10F6
       39
                             rts
10F7
                                        AciaCsr1
       F6 F900
                 SendTerm
                             1da b
                                                   get status
       C4 02
10FA
                             and
                                b
                                        #2
                                                   test for transmit
10FC
       27 F9
                                        SendTerm
                                                   wait for ready
                             bea
       87 F901
                                        Aciabatat
10FF
                             sta
1101
       39
                             rts
                 * Entry point for the I/C interrupt
       B6 F992
1102
                 IOInt
                             1da a
                                        AciaCsr2
                                                   get status
1125
       2A 47
                            bp1
                                        KbInt
                                                   chk for acia interr
1107
       86 F903
                                        AciaData2 get line data
                 Acia2Int
                             1da a
1184
       DE 51
                             1 dx
                                        ActaState
1100
       BE AR
                             jmp
                                                   go to ACIA routine
110E
       86 F901
                 KbInt
                             1 da
                                        AciaData1
                                                   get kb data
       84 7F
                                        #$71
                                                   kill parity bit
1111
                             and
                                 а
1113
       D6 6F
                             ida b
                                        BlockKb
                                                   chk if sending file
                                        ChkC1 i
1115
       27 05
                            bea
                 OutBel1
1117
       86 07
                             1 da
                                        #bel1
                                а
1119
       8D DC
                 OutTerm
                            bsr
                                        SendTerm
                                                   send char to term
111B
       3 B
                             rti
                                                   return
1110
       D6 6A
                 ChkCli
                             1 da
                                        KbState
                                        C11
111E
       26 13
                            bne
1120
       81 96
                            CMP
                                а
       27 95
                                        StartCli
1122
                            bea
                                        SendTerm
1124
       8D D1
                             bsr
                                                   send char to term
                                        SendChar
1126
       BD C2
                             bsr
1128
       3 B
                             Pti
                                                   return
1129
         1278
                 StartCli
                                        #SPCTxt
                             1 dx
                                                   output S!
                                                                          Listing 1 continued on page 276
```



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Listing 1	continued.					
1120	BD 11B	2	Jsr		OutText	
112F	70 006	A	inc		KbState	
1132	38		rti			return
1133	81 90	Cli	CMP	a	#cr	check for CR
1135	27 46		beq		Convert	
1137	81 18		CMP	a	# * X	check for ctrl x
1139	27 29		bea		Cancel	
1138	81 08		CMP	a	#bs	check for backspace
1130	27 32		bea		BackUp	
113F	36		psh	a		save for display
1140	Bu 30		sub	а	#\$30	check for valid hex char
1142	2B 1D		bm1		BadChar	
1144	81 09		CMD	a	#9	
1146	2F 0A		ble		CharOK	
1148	81 31		CMP	а	#\$31	
114A	2B 15		bmi		BadChar	
114C	81 36		CMP	a	#\$36	
114E	2E 11		bgt		BadChar	
1150	80 27		sub	а	#\$27	
1152	DE 5D	CharOK	1 dx		KbPtr	check for overflow
1154	8C 906	3	CPX		#KbEnd+1	
1157	27 08		hea		BadChar	
1159	A7 80		sta	a	×	
1158	88		inx			
115C	DF 5D		stx		KbPtr	
115E	32		pul	a		get original char
115F	20 88		bra		Outlerm	echo for display
1161	32	BadChar	pul	a		pull off stack
1162	20 83		bra		OutBell	
1164	CE 127	5 Cancel	idx		*CRLF	output a cr, 1f
1167	8D 49		bsr		OutText	
1169	97 6A		sta	a	KhState	cir KbState
116B	CE 805	FinzPtr	1 dx		#KbBuff	

Listing 1 continued on page 278

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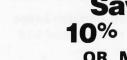
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116E		50		stx		KbPtr	inz ptr	
1170	3B			rti			return	
1171	DE	50	BackUp	1 dx		KbPtr	check for underflow	
1173	80	005F		CPX		#KbBuff		
1176		9F		bea		OutBell		
1178	09			dex			decr KbPtr	
1179		50		stx		KbPtr		
1178	20			bra		OutTerm		
1170		005F	Convert	1 dx		#KbBuff	point at buffer	
1180	_	3 A		bsr		Byte	get a byte	
1182	97	58		sta	а	BinVal	put in ms byte	
1184		36		bsr	_	Byte	get a byte	
1186	1	5C		sta	а	BinVal+1		
1188		58		1 dx		BinVel	get binary number	
118A		6A		1 da	a	KbState	check fsm state	
118C		01		CMP		#1		
118E		07		bne		TryZ		
1190		54		stx		SrcAddr		
1192		1270		1 dx		*DestTxt	display D:	
1195		29		bra		DispText		
1197	81	200	Try2	CMD	А	#2		
1199	26	ØC	, , , ,	bne		Trv3		
1198	1000	56		stx		DestAddr		
1190	CE	1282		ldx		#BCntTxt	display #:	
1140		10	Displext	bsr		OutText	3132131	
1145		996A	Sispient	inc		KbState		
1145		C4		bra		InzPtr		
11A7		58	Trv3	stx		ByteCnt	save byte count	
1149		006A	1193	clr		KbState	5070 5710 550	
		6D		sta		XmitFile	set send file event	
11AC		6F		sta		BlockKb	lock the kb	
11AE				bra		InzPtr	TOCK THE KD	
1180	20	B9		ога	iewo e	Inzrii		
1182	A 6	88	OutText	Ida	a	×	get cher	
1184	27	13		bea		Retn6		L
								-

Listing 1 continued on page 280

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Listing 1	cont	inued:					
1186		10F7		isr		SendTerm	send char to term
1189	08			inx			
1184	20	F6		bra		OutText	
11BC	46	99	Byte	1 da	a	×	
11BE	08			inx			
11BF	48			asl	а		
1100	48			asi	a		
1101	48			asi	a		
1102	48			asl	а		
1103	36			psh	8		
1104	A6	90		1 da	a	×	
1106	48			inx			
1107	33			pul	b		
1108	18			aba			
1109	39		Retnb	rts			
			* Routine	whic	h hand	dles incom	ing ACIA characters
11CA	BD	124F	LineInput				
	00	1641	FILETUDAL	jsr		GetByte	get next char
1100	81		InzAcia	CWD	a	#dle	get next char check for die char
	10000000000	90			a		check for dle char
11CD	81 27	90		CMD	a	#d1e	
11CD 11CF	81 27 8D	90	InzAcia	cmp beq	a	#dle FrameSt	check for dle char
11CD 11CF 11D1	81 27 8D	90 05 10F7	InzAcia	cmp beq jsr	а	#dle FrameSt SendTerm	check for dle char
11CD 11CF 11D1 11D4	81 27 80 20	90 05 10F7 F4	InzAcia Out	cmp beq sr bra		#dle FrameSt SendTerm LineInput	check for dle char
11CD 11CF 11D1 11D4 11D6	81 27 80 20 80	90 05 10F7 F4	InzAcia Out	cmp beq sr bra bsr		#d1e FrameSt SendTerm LineInput GetByte	check for dle char send char to term
11CD 11CF 11D1 11D4 11D6 11D8	81 27 80 80 81	90 05 10F7 F4 77 82	InzAcia Out	cmp beq jsr bra bsr cmp	a	#dle FrameSt SendTerm LineInput GetByte #stx	check for dle char send char to term
11CD 11CF 11D1 11D4 11D6 11D8 11DA 11DC	81 27 80 80 81 26	90 05 10F7 F4 77 82 60	InzAcia Out	cmp beq lsr bra bsr cmp bne	a b	#dle FrameSt SendTerm LineInput GetByte #stx	check for dle char send char to term
11CD 11CF 11D1 11D4 11D6 11D8 11DA 11DC	81 27 80 80 81 26 5F	90 05 10F7 F4 77 82 60	InzAcia Out	cmp beq lsr bra bsr cmp bne clr	a b b	#dle FrameSt SendTerm LineInput GetByte #stx ErrNack	check for dle char send char to term
11CD 11CF 11D1 11D4 11D6 11D8 11DA 11DC	81 27 8D 20 8D 81 26 5F D7	90 05 10F7 F4 77 82 60	InzAcia Out	cmp beq lsr bra bsr cmp bne clr sta	a b b	#dle FrameSt SendTerm LineInput GetByte #stx ErrNack ChkSum	check for dle char send char to term check for stx char
11CD 11CF 11D1 11D4 11D6 11D8 11DA 11DC 11DD	81 27 8D 20 8D 81 26 5F D7 8D	90 05 10F7 F4 77 82 60	InzAcia Out	cmp ber bra bsr cmp bnl sta	а b b b	#dle FrameSt SendTerm LineInput GetByte #stx ErrNack ChkSum ChkSum+1 GetByte SaveOpc	check for dle char send char to term check for stx char
11CD 11CF 11D1 11D4 11D6 11D8 11DA 11DC 11DD 11DF 11E1	81 27 8D 20 8D 81 26 5F D7 8D	90 95 10F7 F4 77 82 60 63 64 60	InzAcia Out	cmp ber bra bsr cmp bclr sta bsr	a b b b	#dle FrameSt SendTerm LineInput GetByte #stx ErrNack ChkSum ChkSum+1 GetByte SaveOpc ##0	check for dle char send char to term check for stx char zero the checksum
11CD 11CF 11D1 11D4 11D6 11D8 11DC 11DC 11DC 11DF 11E1 11E3	81 27 80 80 81 26 5F 07 80 97	90 05 10F7 F4 77 82 60 63 64 60 50	InzAcia Out	cmp bear bra bsr cmp bra cmp cta sta bsr sta	a b b b	#dle FrameSt SendTerm LineInput GetByte #stx ErrNack ChkSum ChkSum+1 GetByte SaveOpc	check for dle char send char to term check for stx char zero the checksum save opcode

Listing 1 continued on page 282

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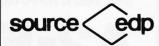
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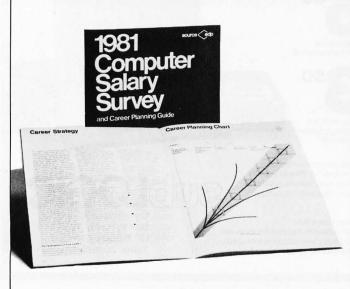
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Listing	I contini	ued:			
11EB	27 4		bea	DataFrm	
11ED	81 3		cmp a	# . 5	check for ack frame
LIEF	27 0	_	bea	VerChk	
11F1	81 3		cmp a	# * 3	check for nack frame
11F3	27 0		beg	VerChk	
11F5	20 5		bra	ErrNack	bad frame
11F7	8D 5		bar	GetByte	get upper addr byte
11F9	97 7	And the second s	sta a	Address	
11FB	80 5		bsr	GetByte	get lower addr byte
11FD	97 7		sta a	Address+1	
11FF	80 4	E VerChk	bsr	GetByte	get dle
1201	8D 4	С	bsr	GetByte	get etx
1203	DE 6	3 Verify	1 dx	ChkSum	save the checksum
1205	DF 7	5	stx	SaveSum	
1207	8D 4	6	ber	GetByte	get upper checksum
1209	97 6	5	sta a	RecdChk	
1208	80 4	2	hsr	GetByte	get lower checksum
1200	97 6	6	sta a	RecdChk+1	
120F	C6 0	1 = 1 = 1	1da b	#1	1 => Ack
1211	DE 6	5	1 dx	RecdChk	
1213	9C 7	5	срх	SaveSum	
1215	27 0	1	bea	SkpCrt	
1217	54		neg b		-1 => Nack
1218	96 5	SkpCrt	lda a	SaveOpc	get opcode
1214	84 9	2	and a	# 5	ignore bit 0
1210	27 W	E	hea	SendAck	
151E	50		tst b		
121F	5B N	7	bmi	SetRACK	error -> recd Nack
1221	96 5		1da a	SaveOpc	get opcode
1223	81 3	2	cmp a	#.5	check for recd Ack
1552	27 0	1	bea	SetRAck	
1227	59		nea b		-1 => recd Nack
					d Ack, -1 => recd Nack
1558	D7 6		sta b	RecdAck	
1554	29 9	E Fin3	bra	LineInput	Listing 1 continued on page 284

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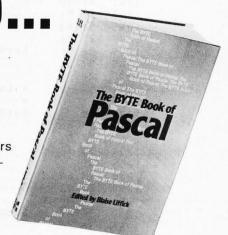
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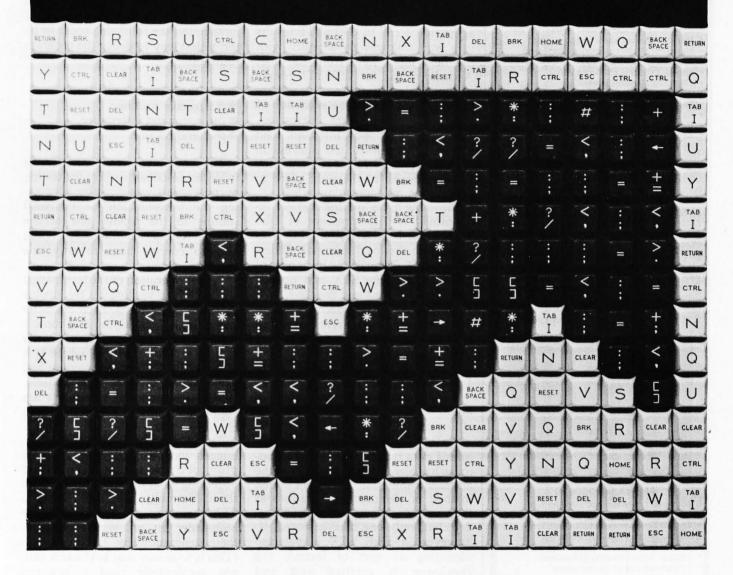
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...end

```
Listing 1 continued:
                                         XmitAck
1220
      D7 6C
                 SendAck
                             sta b
                 * XmitAck: 2 => nop, 1 => xmit Ack, -1 => xmit Nack
                                         LineInput
       20 9A
                             bra
122E
1230
       8D 1D
                 DataFrm
                             bsr
                                         GetByte
                                                    check for doubled dle
1232
       81 90
                             cmp a
                                         #dle
       27 49
                             bea
                                         ChkDble
1234
1236
       DE 79
                 OkDbie
                             1 dx
                                         Address
                                                    store byte
1238
       A7 00
                             sta a
       8 19
                             inx
123A
                                         Address
       DF
          79
                             stx
123B
                                         DataFrm
       20 F1
                             bra
1230
123F
       BD ØE
                 ChkDble
                                         GetByte
                                                    throw away first dle
                             bsr
1241
       81 90
                             cmp a
                                         #dle
                                         Okoble
       27 F1
                             bea
1243
1245
       81 83
                             cmp a
                                         #etx
                                                    check for frame end
                                         Vertfy
                                                     frame error
1247
       27 BA
                             beq
       86 FF
                 ErrNack
                                                    send Nack event
                             1da a
                                         #-1
1249
                                         XmitAck
124B
       97 6C
                             sta
                                         Fin3
1240
       20 DB
                             bra
                 * Exit routine which saves the return address,
                      undates the checksum, and does rti
124F
       30
                 GetByte
                             tsx
1250
       EE an
                             1dx
                                                    get entry point
                                         AciaState save return addess
1252
       DF 51
                             stx
1254
                             ins
       31
1255
       31
                             ins
                                                    get off stack
                                         ChkSum+1
1256
       98 64
                             add a
1258
       24 03
                             bcc
                                         SkpUpper
125A
       70 0063
                             inc
                                         ChkSum
                                         ChkSum+1
       97 64
                 SkpUpper
                             sta a
1250
125F
       3B
                             rti
                                                    return
                 AckFrm
                                         dle, stx, 2, dle, etx, 1, $44
1268
          90
                             fcb
1261
          82
1262
          32
          90
1263
1264
          83
1265
          01
1266
          44
          90
                 NackFrm
                                         dle, stx, '3, dle, etx, 1, $45
1267
          82
1268
1269
           33
          90
1264
126B
          83
1260
          01
          45
1260
          22
                                         / Failed/
126E
                 ErrorMsq
                             fcc
          46
126F
1279
          61
1271
           69
          60
1272
1273
          65
1274
          64
                 CRLF
          OD
1275
                             fcb
                                         $d, $a, 0
1276
          MA
          00
1277
1278
          20
                 SrcTxt
                             fcc
                                         / S: /
1279
          53
127A
          34
1278
          22
1270
          90
                             fcb
1270
          20
                 DestTxt
                             fcc
                                         / D: /
127E
          44
127F
          34
1280
          20
1281
          00
                                         0
                             fcb
1282
          20
                 BCntTxt
                             fcc
                                         1 #1 /
1283
          23
1284
          3 A
1285
          20
                                         0
1286
          00
                             fcb
```

end

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Text continued from page 268:

put from the serial line; it detects frames, parses them, and performs the appropriate action. The state of the receive program is saved whenever calls to GETBYTE are made. (It is conceptually easier to imagine that a call to GETBYTE results in a wait followed by a return with the next input byte from the line. Actually, a call to GETBYTE results in the storing of the return address in ACIASTATE and the execution of a return from interrupt instruction. The next line input interrupt then causes a branch to the address in ACIASTATE, which reenters the receive routine at the right place to process the next incoming byte.)

Incoming bytes are first checked sequentially for the presence of DLE bytes. If a byte is not a DLE, it is printed on the local terminal. Otherwise, the DLE signals the beginning of a frame, and the STX and opcode bytes are received and checked.

An opcode of hexadecimal 30 implies that the next 2 bytes are to be stored in ADDRESS, high-order byte first. The checksum is then tested. If it is correct, the XMITACK flag is set to 1; otherwise, the XMITACK is set to —1. The send module will eventually notice this work request and issue either an ACK or a NAK frame.

An opcode of hexadecimal 31 implies a data frame. Since the start address has already been verified in the address frame, data bytes are stored in their proper memory locations as they arrive. When a DLE DLE is detected, only one DLE is stored. If, however, a DLE ETX is detected (denoting an end of frame), the checksum is verified and and XMITACK flag is set accordingly.

An opcode of hexadecimal 32 implies receipt of an ACK frame, and an opcode of hexadecimal 33 implies receipt of a NAK frame. Both are verified for accuracy by comparing the computed checksum to the received checksum, and the RECDACK flag is set accordingly. This informs the send module whether the next address or data frame may or may not

At the end of each frame, control returns to the beginning of the receive program so that the next frame (or stream of keyboard characters) may be properly interpreted.

Debugging

Debugging is best accomplished if the code can be separated into modules that can be tested independently. As indicated earlier, there are three major modules: the command interpreter, the send routine, and the receive routine. I have found the following order to be the easiest way to debug the program routines:

- the transparent mode routine
- the receive routine
- the command interpreter
- the send routine

The computer was connected to itself, as described earlier, for testing purposes; this was done by connecting the transmit line of the send routine to the receive line of the receive routine. In this way, I was able to confine bugs to only one machine.

Proper operation of the transparent mode code is verified by the double echo on the terminal. Each character typed in is echoed on the console from the send routine. The character is then sent on the line, where it is received by the receive routine and again typed on the same console. When two separate computers are connected, of course, only one character is typed on each console.

The receive routine can be debugged independently by keying in protocol frames on the keyboard and observing what the receiver does with them. Normally, the DLE, STX, and ETX characters are defined with the high-order bit on, which precludes their generation by the keyboard. (This is to ensure that keyboards cannot accidentally send a protocol frame.) During debugging, however, the value of the DLE, STX, and ETX bytes can be changed to keyboardgenerated characters, thereby allowing frame synthesis through the keyboard for debugging purposes only.

The send routine must be disabled during this stage of debugging by changing the BNE INZADOR at hexadecimal location 1045 to BRA XMITLOOP. This ensures that the XMITACK flag from the receive module does not cause an ACK or NAK to be sent, thus clearing the

First, an acknowledge frame is

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keyed in to test the receive routine's response. The RECDACK byte, as a result, should be set to a value of +1. Next, a NAK frame is keyed, which should get the RECDACK byte to -1. If these received frames do not result in the proper setting of the flags, then either the receive routine is faulty, or the frame was keyed incorrectly.

After a proper address frame is typed, the XMITACK flag should be set to 1; otherwise, it should be set to -1. Also, a proper address frame should put the address types in the 2-byte variable ADDRESS.

Finally, frames of varying length and content should be typed in, and memory should be checked to ensure that the data has been properly stored. Of course, the keyboard cannot generate bytes with the high-order bit on, but this should not affect the debugging process. A proper data frame should set the XMITACK flag to 1, while a bad frame should set it to -1.

The command interpreter is debugged next by typing a control-F character and noticing that an "S:" is typed on the console. Typing in four hexadecimal characters and a carriage return should result in a "D:" being typed on the console. The command interpreter checks for valid hexadecimal characters, which in this implementation are lowercase "0" thru "9" and "a" thru "f." Either typing in a bad character, or typing more than five characters, results in the ringing of the terminal's bell.

After the destination address is keyed, a "#:" should be typed on the console. When the byte count and a carriage return are typed, the user should cause system reset and go to the computer's monitor program (in my case, a Motorola MIKBUG). Locations SRCADDR, DESTADDR, and BYTECNT should contain the proper values of the three parameters just typed in. Also, the XMITFILE flag should be nonzero. If any of the above information is not correct, the command interpreter has errors and must be debugged.

The debugging of the send routine is the last and most difficult task. The patch introduced to disable the send routine must be deleted and the original code restored. The command interpreter is then used to set up the addresses and a byte count; a carriage return is struck to initiate the send

routine. Normally, the send routine will send out an address frame and wait for the RECVDACK flag to indicate proper receipt of the frame. It will then send a data frame and again wait for the RECVDACK flag. Since the transmit line is connected to the receive line during these tests, a more complicated interaction occurs.

The interaction is as follows—the sender issues an address frame and the receiver, in turn, sets the XMITACK flag. The sender sees the XMITACK and sends an ACK frame, and the receiver receives the ACK and sets the RECVDACK flag. The sender, noticing the RECVDACK flag, sends a data frame. Errors result in up to three retransmissions before the file transfer is aborted and the computer returns to transparent mode. This sequence of events can be verified by disabling various portions of code and watching the flags change using a debugging routine (there is usually one in the computer's monitor program).

Once the software routines have been independently debugged as described above, there should be few problems when a final test is made with two computers linked by a serial

line.

Final Notes

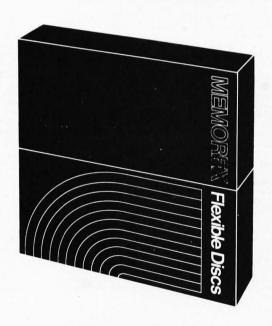
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The protocol presented here is computer independent and could just as well be implemented in the machine language of any microprocessor. As long as there is agreement on the electrical interface and on the data-transfer protocol, a computer can pass data of any kind

to any other computer.■

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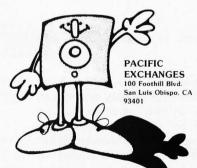
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Three-Dimensional Computer Graphics, Part 2

Franklin C Crow Department of Computer and Information Service Ohio State University 2036 Neil Ave Mall Columbus OH 43210

Last month, in Part 1, we examined almost every algorithm needed to display three-dimensional line drawings that represent solid objects modeled by polygons. I attempted to keep the procedures concise, at the occasional sacrifice of clarity or efficiency.

Listing 1 contains a complete Pascal program that incorporates the individual graphics procedures presented in Part 1. I have used this program with the Heath/Zenith H-19 video terminal (which has limited semigraphics) and the UCSD (University of California, San Diego) Pascal system. I have also used it (very satisfactorily) with a 500-line raster graphics display and a Pascal interpreter running under the UNIX operating system on a DEC (Digital Equipment Corporation) VAX 11/780 computer.

The program includes facilities for all of the basic functions necessary for three-dimensional representation:

- •acquisition of machine-readable data
- •transformation to the proper perspective
- scaling
- •elimination of hidden lines and faces

In presenting this program, I have assumed that your display system can draw lines, as most systems that are capable of full graphics provide appropriate software. However, scanconversion software is included to support the Heath/Zenith H-19 video terminal, and the routines Moveto and Drawto can be easily modified

for any other raster display.

As designers continue to simplify the use of personal computers, the area of three-dimensional graphics software will be the next to receive significant attention. ■

Listing 1: Complete UCSD Pascal three-dimensional graphics program that incorporates the ideas and procedures put forth in Part 1 (see March 1981 BYTE, page 54).

```
Program HideLine;
const
        DotsAcross = 79;
   DotsDown = 47;
   MaxPts = 200;
   MaxPols = 200;
   MaxVtx = 800;
   MaxSides = 8;
                      (* maximum sides on a polygon *)
   pe counter = O..MaxVtx;
Point = record X.Y.Z : real end;
Vertex = O..MaxPts;
   Polygon = record NumVtx : Vertex: Start : counter:
   OnePoly = array [1.. MaxSides] of Point;
   Folygons : array [i..MaxPols] of Polygon;
                                                       (* original polygons
   Vertices : array [1. MaxVtx] of Vertex;
OutPolys : array [1. MaxPols] of Polygon;
OutVtces : array [1. MaxVtx] of Point;
                                                       (* original vertices
                                                                                  #)
                                                       (* displayed polygons *)
                                                       (* displayed points
   EyeSpace : Matrix;
Window : OnePoly;
                                                       (* eye space transform *)
                                                       (* display window
   EyePt,CntrInt : Point;
ScreenScale,ScreenCtr : Point;
                                       (* eyepoint and center of interest
   ScreenX, ScreenY : real;
   Screen : packed array [O., DotsAcross, O., DotsDown] of boolean; NumPols, NumVtces, NumPts, WindowSize, I : counter;
   NumDisplay, NumVtxOut : counter;
   CmdChar : char;
FileName : string;
   Done : boolean;
procedure GetPlanes( var Poly : OnePoly; NumPts : counter );
 ImpPoly: OnePoly;
              (* compute plane equation coefficients for polygon edges *)
 LstI := NumPts:
 for I:≕1 to NumPts do
with Poly[I] do
    begin
    Degin
impPoly[I].X := Y * Poly[LstI].Z - Z * Poly[LstI].Y;
TmpPoly[I].Y := Z * Poly[LstI].X - X * Poly[LstI].Z;
    TmpPoly[I]. Z := X * Poly[LstI]. Y - Y * Poly[LstI]. X;
LstI := I;
end; (* for loop *)
for I:-1 to NumPts do
                             (* copy back to input *)
with TmpPolyfII do
begin PolyfII.X:=X; PolyfII.Y:=Y; PolyfII.Z:=7; end;
end; (* GetPlanes *)
 procedure GetScreenScale:
                                (* get window to screen scale factor *)
 var I : counter;
                                                            Listing 1 continued on page 292
```

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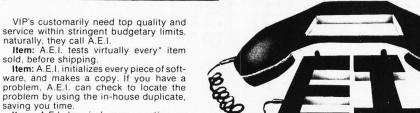
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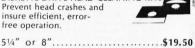
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```
Listing 1 continued:
  MaxX, MinX, MaxY, MinY : real;
 MaxX:=0.0; MinX:=0.0; MaxY:=0.0; MinY:=0.0;
                                                          (* window must include 2-axis
 for I:=1 to WindowSize do
with Window[I] do
     begin
     if X/Z > MaxX then MaxX := X/Z;
     if X/Z < MinX then MinX := X/Z;
if Y/Z > MaxY then MaxY := Y/Z;
     if Y/Z < MinY then MinY := Y/Z;
     end;
 MaxX := MaxX - MinX;
                                    MaxY := MaxY - MinY;
 if MaxY > (0.75 * MaxX)
 if MaxY > (0.75 * MaxX) (* standard display is 3 units high by 4 wide *) then ScreenScale Z := (MaxY * 4 / 3 ) else ScreenScale Z := MaxX;
 ScreenScale.X := DotsAcross / ScreenScale.Z;
ScreenScale.Y := ( DotsDown * 4 / 3 ) / ScreenScale.Z;
 end;
           (* GetScreenScale *)
 procedure Initialize;
                              (* set default parameter values *)
 begin
 Done := false:
 NumPols := 0;
 NumDisplay :=
 NumVtces ;= 0;
NumPts := 0;
 with EyePt do begin X_1 = -5, O_1 = Y_2 = -5, O_2 = Z_3 = 3.
 with CntrInt do begin X:=0.0; Y:=0.0; Z:=0.0;
 WindowSize := 4;
 with Window[1] do begin X:=-4, O; Y:=-3, O; Z:=16, O; with Window[2] do begin X:=-4, O; Y:=-3, O; Z:=16, O; with Window[3] do begin X:=-4, O; Y:=-3, O; Z:=16, O; with Window[4] do begin X:=-4, O; Y:=-3, O; Z:=16, O; with Window[4] do begin X:=-4, O; Y:=-3, O; Z:=16, O;
                                                                      end;
                                                                      endi
                                                                      end:
 GetScreenScale;
 GetPlanes( Window,WindowSize );
 with ScreenCtr do begin X:=DotsAcross/2; Y:=DotsDown/2; end; end; (* Initialize *)
 procedure Start;
 var I.J : counter;
 begin
          (* clear screen *)
 for I := 0 to DotsAcross do
for J := O to DotsDown do Screen[ I,J ] := false;
          (* start *)
 end:
 procedure Finish;
                              (* display output for Zenith H-19 terminal *)
 Var
       I.d : counter;
 begin
 write(chr(27), 'F'); (* put terminal into graphics mode *)
write(chr(27), 'p'); (* put terminal into reverse video *)
write(chr(27), 'w'); (* no wraparound at end of line *)
 J := DotsDown;
 while J > O do
begin
for I := O to DotsAcross do
    if Screen[I, J] and Screen[I, J-1] then write(/q/)
     else if Screen[I, J-1] then write(<1/)
         else if Screen[I,J] then write(/o/)
else write(* /);
if J > 1 then J := J - 2 (* count down by twos *)
else J := 0;
if J > 0 then writeln;
                                (* CR/LF unless last line *)
end:
 readln; (* await <CR> before continuing (preserves screen) *)
 write(chr(27), <q'); (* exit graphics mode *) write(chr(27), <q'); (* exit reverse video *)
          (* Finish *)
 end;
 procedure Moveto( X,Y : real );
 begin
 ScreenX := X;
                         ScreenY := Y;
          (* Moveto *)
 end;
 procedure Drawto( X,Y : real );
       I : counter;
  Dx. Dy. Length. StepX. StepY. Xpos. Ypos : real;
 begin
         (* Drawto *)
Dx := X - ScreenX; Dy := Y - ScreenY; if abs(Dx) \supset abs(Dy) then Length := abs(Dx) else Length := abs(Dy); if Length < 1.0 then Length := 1.0; (* catch zero-length lines *)
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*Time estimates based on 4Mhz 8085 with 48K memory, CP/M 2.1 double density 8" floppy drive, 10,000-word text file.



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```
Listing 1 continued:
                       StepY := Dy / Length;
StepX := Dx / Length;
Xnos := ScreenX;
                   Ypos := ScreenY;
 for I := O to trunc(Length) do
Screen[round(Xpos),round(Ypos)] := true;
endi
 ScreenX := X;
                 ScreenY := Y;
       (* Drawto *)
 end)
 Xpos, Ypos, Zpos : real;
ObjFile : file of char;
 write(<Position for <,FileName, < X Y Z : <); readln(Xpos,Ypos,Zpos);
reset(ObjFile,FileName); (* open object file *)
readln(ObjFile,PtsObj,PolsObj);</pre>
 for I:=1 to PtsObj do with Points[[+NumPts] do
begin
readin(ObjFile, J. X. Y. Z);
X := X + Xpos; Y := Y + Ypos; Z := Z + Zpos;
endi
 for I:=1 to PolsObj do
begin
read(ObjFile,PtsPol);
                  (* read polygon vertex pointers *)
for J := 1 to PtsPol do
   begin
   read(ObjFile, Vertices[J+NumVtces] );
   Vertices[J+NumVtces] := Vertices[J+NumVtces] + NumPts;
readin(ObjFile); (* read past end of line *)
with Polygons[I+NumPols] do
   begin
   Start := NumVtcesi
   NumVtx := PtsPol;
NumVtces := NumVtces + PtsPol;
end:
 NumPts := NumPts + PtsObj;
 NumPols := NumPols + PolsObj;
       (* ReadObject *)
 procedure MakePicture;
                    (* transform and clip, then display polygons *)
     I.J.NumClp : counter;
  TmpPoly: OnePoly;
begin
DotProd := Pti. X * Pt2. X + Pt1. Y * Pt2. Y + Pt1. Z * Pt2. Z ;
end;
      (* DotProd *)
I.J : counter;
var
begin
for I:=1 to 4 do
   for J:=1 to 4 do
if 1 = J then Mtx[I,J] := 1.0 else Mtx[I,J] := 0.0;
       (* Ident *)
procedure MatrixMult( Mtl,Mt2 : Matrix; var Result : Matrix );
    I.J.K : counter:
begin
for I:=i to 4 do
   for J:=1 to 4 do
       begin
      Result[I, J] := 0.0;
       for K:=1 to 4 do
          Result[I,J] := Result[I,J] + Mti[K,J]*Mt2[I,K];
       enda
endi
       (* MatrixMult *)
procedure Transform( Pt : Point; Mtx : Matrix; var NewPt : Point );
NewPt, Z := Pt, X*Mtx[3,1] + Pt, Y*Mtx[3,2] + Pt, Z*Mtx[3,3] + Mtx[3,4];
      (* Transform *)
endi
```

Listing 1 continued on page 296

HAS THE FEAT

Computer experts (the pros) usually have big computer experience. That's why when they shop system software for Z80 micros, they look for the big system features they're used to. And that's why they like Multi-User OASIS. You will too.

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Pros demand file & automatic record locking. OASIS has it.

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Controlling who gets on your system and what they do once they're on it is the essence of system security.

HEN COMPARE.)

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And multi-users can multiply the problem.

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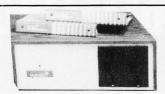
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```
Listing 1 continued:
```

```
procedure GetEyeSpace( EyePt, CntrInt : Point );
    Mtx : Matrix;
C1,C2 : Point;
      Hypotenuse, CosA, SinA: real;
begin
ldent(EyeSpace);
                         (* load eyepoint translation *)
with EyePt do
begin EyeSpace[1,4]:=-X; EyeSpace[2,4]:= -Y; EyeSpace[3,4]:= -2; end; fransform( CntrInt,EyeSpace,Cl ); (* translate ctr. of interest *)
               (* load rotation about Z-axis *)
with CI do Hypotenuse := sqrt( X*X + Y*Y ); if Hypotenuse > 0. O then
    begin
    CosA := Ci. Y / Hypotenuse:
                                     SinA := C1. X / Hypotenuse;
    MatrixMult( EyeSpace, Mtx, EyeSpace );
    end;
Transform( CntrInt, EyeSpace, C2 ); (* rotate ctr. of interest *)
if Hypotenuse > 0.0 then
    begin /¹
CosA := C2. Y / Hypotenuse;
    CosA := C2.Y / Hypotenuse; SinA := -C2.Z / Hypotenuse; Mtx[2,2] := CosA; Mtx[3,2] := SinA; Mtx[2,3] := SinA; Mtx[2,3] := CosA;
    MatrixMult( EyeSpace, Mtx, EyeSpace );
Ident(Mtv):
               (* load switch between Y and Z axes *)
MatrixMult( EyeSpace, Mtx, EyeSpace );
        (* GetEyeSpace *)
procedure MakeDisplayable( var Pt : Point ); (* take to screen space *)
begin
Pt. X := ScreenScale, X * Pt. X / Pt. Z + ScreenCtr. X;
Pt. Y := ScreenScale, Y * Pt. Y / Pt. Z + ScreenCtr. Y;
       (* MakeDisplayable *)
end;
function FacesEye( Poly : OnePoly ) : boolean;
var TmpPt: Forns.
TmpPoly: OnePoly;
begin
with Poly[2] do
begin TmpPt. X:=X; TmpPt. Y:=Y; TmpPt. Z:=Z; end;
TmpPolyCll. X := PolyCll. X - PolyC2l X;
TmpPolyCll. Y := PolyCll. Y - PolyC2l Y;
TmpPolyE13. Z := PolyE13. Z - PolyE23. Z;
TmpPolyE23. X := PolyE33. X - PolyE23. X;
TimpPoly[2]. Y := Poly[3]. Y - Poly[2]. Y;
TmpPoly[2]. Z := Poly[3]. Z - Poly[2]. Z;
GetPlanes( TmpPoly, 2 );
if DotProd( TmpPt, TmpPoly[1] ) <= 0.0
   then FacesEye := false
else FacesEye := true;
       (* FacesEye *)
end:
procedure ClipIn(var Poly : OnePoly; var NumPts : counter);
var I, J, LstJ, TmpPts : counter;
      D1, D2, A : real;
      ImpPoly : OnePoly;
begin
for 1:=1 to WindowSize do (* for each window edge *)
    if NumPts > 0 then
        begin
        Di := DotProd( Poly[NumPts], Window[I] );
        LstJ := NumPts;
        ImpPts := 0;
        for J:=1 to NumPts do
                                      (* for each polygon edge *)
           begin
if D1 > 0.0 then
                                    (* is leading vertex inside? *)
                begin
                TmpPts := TmpPts + 1;
                with TmpPolyETmpPtsJ do
                     begin (* copy leading vertex *)
X: =Poly[LstJ], X; Y: =Poly[LstJ], Y; Z: =Poly[LstJ], Z;
                     end:
```

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Listing 1 continued:

```
end; (* if leading vertex inside *)
           D2 := DotProd( Poly[J], Window[]] );
             if D1 * D2 < 0.0 then (* does edge straddle window? *)
                 A := D1 / (D1 - D2);
                 TmpPts := TmpPts + 1;
                 with TmpPoly[TmpPts] do
                     begin
                     X := A * Poly[J], X + (1, O - A) * Poly[LstJ], X;

Y := A * Poly[J], Y + (1, O - A) * Poly[LstJ], Y;

Z := A * Poly[J], Z + (1, O - A) * Poly[LstJ], Z;
                      end;
                 endi
             Lstd := Ji
            D1 := D2;
                    (* NumPts loop *)
            end;
        for J:=1 to TmpPts do
                                  (* copy polygon back to input *)
            with TmpPoly[J] do
  begin Poly[J], X:=X; Poly[J], Y:=Y; Poly[J], Z:=Z; end;
        NumPts := TmpPts:
                 (* WindowSize loop *)
        endi
        (* ClipIn *)
procedure InsertSort( Poly : OnePoly ; NumPts : counter );
      I.J.K : counter;
AvDepth : real;
begin
             (* binary insertion sort on average depth *)
AvDepth := 0.0;
for I:=1 to NumPts do
    with PolyLII do
                          (* store and find average depth *)
         begin
        (utVtces[NumVtxOut+1+1], X := X;
        OutVtces[NumVtxOut+I+1]. Y := Y;
         (utVtces[NumVtxOut+I+1], Z := Z;
        AvDepth := AvDepth + Z;
end;
AvBepth := AvBepth / NumPts;
OutVtces[NumVtxOut+1], Z := AvDepth;
            (* initialize for insertion search *)
I := (NumDisplay + 1) div 2;
K := NumDisplay;
while (J \Leftrightarrow I) do
                       (* binary search for insertion point *)
    if AvDepth < OutVtces[ OutPolys[I], Start ]. Z
       then begin K := I; I := (I + J) div 2; end else begin J := I; I := (I + K + I) div 2; end;
for J:=NumDisplay downto I+1 do
    begin
    OutPolys[J+i]. Start := OutPolys[J]. Start;
    OutPolys[J+1]. NumVtx: = OutPolys[J]. NumVtx;
    endi
OutPolys[I+i] Start := NumVtxOut + i;
OutPolys[I+i] NumVtx: = NumPts;
NumVtxOut := NumVtxOut + NumPts + 1;
NumDisplay := NumDisplay + 1;
end; (* InsertSort *)
procedure ClipOut( Poly : OnePoly; var NumPts : Vertex; Place : counter);
var I.LstI.NumDrawn : counter;
    Pt1, Pt2 : Point;
    Drawn : boolean;
    procedure ClipAfter( Index : counter; Pt1,Pt2 : Point);
               counter;
          D1, D2, A : real;
          Out : boolean;
Pt3 : Point;
    begin (* recursively check polygons for overlap with input edge *) if Index < Place (* is polygon closer than edge? *) then with OutPolys[Index] do
         begin
         I := Start + NumVtx;
Out := false;
         repeat (* for each polygon edge *)
             DI := DotProd( Ptl, OutVtces[I] );
              D2 := DotProd( Pt2.OutVtces[I] );
              if (01 \leq 0,0) and (D2 \leq 0,0) then begin (* both points visible *) Out := true;
                   ClipAfter( Index+1,Pt1,Pt2 );
              else if Di * D2 < 0.0
                   then begin (* one point visible *) A := D1 / (D1 - D2);
```

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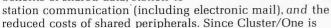
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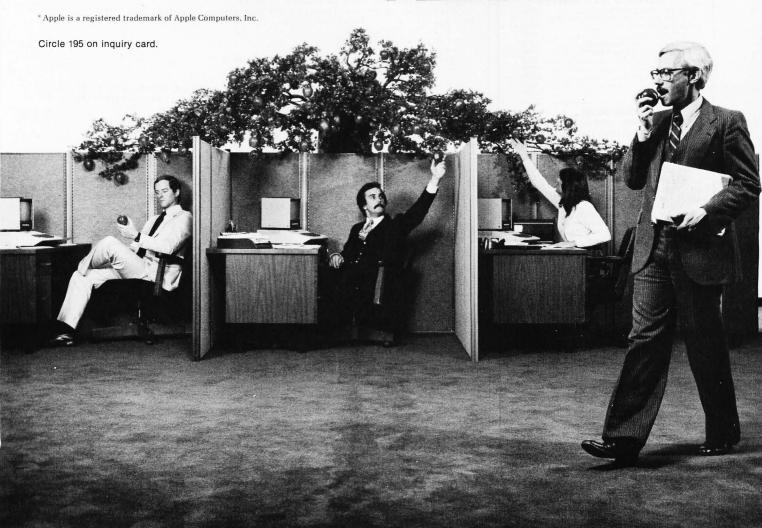
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Listing 1 continued:

```
Pt3. X := A * Pt2. X + (1.0-A) * Pt1. X; Pt3. Y := A * Pt2. Y + (1.0-A) * Pt1. Y;
                              Pt3. Z := A * Pt2. Z + (1.0-A) * Pt1. Z;
                              if D1 < 0.0
                              then begin
                                                 (* Pti visible *)
                                    ClipAfter( Index+1,Pt1,Pt3 );
                                    with Pt3 do
                                         begin Pti. X:=X; Pti. Y:=Y; Pti. Z:=Z; end;
                                     end
                                                 (* Pt2 visible *)
                              else begin
                                    ClipAfter( Index+1,Pt3,Pt2 );
                                    with Pt3 do
                                         begin Pt2, X:=X; Pt2, Y:=Y; Pt2, Z:=2; end;
                                    end;
                                      (* one point visible *)
                 I \cdot = I - 1;
           until Out or (I = Start); (* all visible or edges exhausted *)
            end
     else begin (* reached end of list of closer polygons *)
           MakeDisplayable( Pt1 ); MakeDisplayable( Pt2 ); Moveto( Pt1 X,Pt1 Y ); Drawto( Pt2 X,Pt2 Y ); Drawn := true; (* mark as displayed *)
            endi
              (* ClipAfter *)
(* ClipOut procedure body *)
         (* clip each poly edge by all closer polys, draw whats left *)
begin
NumDrawn := 0;
LstI := NumPts;
for I:=1 to NumPts do
    begin
     with Poly[LstI] do begin Pt1. X:=X; Pt1. Y:=Y; Pt1. Z:=Z; end; with Poly[I] do begin Pt2. X:=X; Pt2. Y:=Y; Pt2. Z:=Z; end;
     Drawn := false:
     ClipAfter( 1.Ft1.Ft2 ); (* check closer polys, then display *) if Drawn then NumDrawn := NumDrawn + 1;
     LstI := Ii
              (* for loop *)
     end;
if Numbrawn = 0 then NumPts := 0; (* mark as hidden *)
         (* ClipOut *)
endi
          (* MakeFicture procedure body *)
 GetEyeSpace( EyePt.CntrInt ); (* get eyespace matrix *)
NumDisplay := 0; NumVtxOut := 0; (* set output counters *)
  for I:=1 to NumPols do
with Polygons[I] do
     begin
for J:=1 to NumVtx do (* get polygon *)
          begin
          with Points[ Vertices[ Start + J ] ] do
          begin TmpPoly(J]. X:=X; TmpPoly(J]. Y:=Y; TmpPoly(J]. Z:=Z;
Transform( TmpPoly(J].EyeSpace.TmpPoly(J] ); (* transform *)
          endi
     if FacesEye( TmpPoly ) then
           begin
          NumClp := NumVtx;
                                    (* protect original data *)
          ClipIn( [mpPoly, NumClp ); (* clip to view window *)
if NumClp > 0 then InsertSort( TmpPoly, NumClp );
                                   (* store in sorted order for display *)
              (* loop for each polygon *)
  (* display surviving polygons, clipping each by closer polygons *)
 Start; (* initialize and clear display *) for I:=I to NumDisplay do
with OutPolys[I] do
     begin
     for J:=1 to NumVtx do
        with OutVtces[ Start + J ] do
   \label{eq:begin} $$ \text{ } \text{Degin } $$ \text{ } \text{TmpPoly[J]. } X:=X; $$ \text{ } \text{TmpPoly[J]. } Y:=Y; $$ \text{ } \text{TmpPoly[J]. } Z:=Z; $$ end; $$ \text{ClipOut( } \text{TmpPoly, NumVtx, I }); $$ (* clip and display *) $$
   if NumVtx > 0 then
         begin
                                                 (* convert to planes *)
         GetPlanes( TmpPoly, NumVtx );
         for J:=1 to NumVtx do (* copy back for later clipping *) with OutVtces[ Start + J J do
                   begin X:=TmpPolyEJ]. X; Y:=TmpPolyEJ]. Y; Z:=TmpPolyEJ]. Z;
           (* for loop (i to NumDisplay) *)
    end:
Finish
               (* finalize picture *)
          (* MakePicture *)
end;
begin
         (* main program *)
Initialize; (* set up default view parameters *)
while not Done do
```

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```
begin
writeln( Cread object, eyepoint, center of interest, start over,
                        window, picture, quitl ();
 eadln(CmdChar);
case CmdChar of
    /r/: begin write('file name: '); readln(FileName);
               ReadObject(FileName);
          end;
    end:
    /c/ : begin write(/center of interest, X Y 7 : /);
               with CntrInt do readln( X, Y, Z );
          end;
    's' : begin NumPols := 0;
                               NumPts := 0;
          end:
    'w' : begin write('display window : how many sides? ');
                readln(WindowSize);
                for I:=1 to WindowSize do
                   begin
                   write(<X Y Z : <);
                   with Window[]] do readln(X,Y,Z);
                    endi
                                   (* get window to screen scale *)
                GetScreenScale
                GetPlanes( Window, WindowSize ); (* get clipping planes *)
          end:
          MakePicture:
    4p4 3
    /q/ : Done := true;
            (* case statement *)
    endi
end;
       (* while loop *)
 end.
         (* main program *)
```

BYTE's Bugs

Adventurous Bugs

As expected, many people called our offices with guestions about the two Adventure programs in the December 1980 BYTE, "Pirate's Adventure" (by Scott Adams, page 192) and "Lost Dutchman's Gold" (by Bob Liddil and Teri Li, page 268). Although the authors found only two errors per se, the following notes are in order:

In listing 2 of "Pirate's Adventure," page 210, line 1240 says:

1240 IF D <> −1 THEN 1330 ELSE INPUT "READY DATA TAPE. HIT ENTER": K\$

while line 1330, the last line given in the listing, says simply:

1330 REM



Photo 1: Jon Swanson, BYTE drafting editor, finds a bug (shown in right hand) at the entrance to the Lost Dutchman Mine.

According to Scott Adams, the listing is correct as stands, because D is set to -1 in line 20 of listing 2 (page 202) to denote a cassette-based program. The lines following line 1330 were deleted by Scott from an earlier version of the program, because they referred to disk commands only. Thus, the variable D should retain the value -1 throughout this program, thereby preventing a branch from line 1240 to line 1330.

There is an error in "Pirate's Adventure." but it affects you only if you tried to combine listings 1 and 2 into a single program for a 32 K-byte TRS-80 (as suggested in column 2 of page 212). The problem occurs when statements in what used to be listing 2 try to read the data directly from the DATA statements that used to be in listing 1. The full directions are:

- 1. Delete lines 6510 to 6790 of listing 1.
- 2. Append the remaining DATA statements from listing 1 to the end of listing 2, changing all occurrences after line 1240 of INPUT#D to READ.
- 3. In listing 2, change line 1280 to:

1280 FOR X=0 TO CL:FOR Y=0 TO 1:READ CA(X,Y):NEXT Y,X

4. In listing 2, change line 1290 to:

1290 FOR X=0 TO NL:FOR Y=0 TO 1:READ NV\$(X,Y):NEXT Y,X

In the listing for "Lost Dutchman's Gold," the lack of a closing quote at the end of line 36 (page 268) caused some confusion. However, the program will run without the quote, so that is not a problem. One occurrence of the invisible Control-D that editor Gregg Williams missed mentioning is on line 4130 (page 280), just before the first letter in the word DELETE.

The error in "Lost Dutchman's Gold" is in the last line of line 1287 (page 274). Change the part that reads "7\$(J,3)" to read "O\$(J,3)" the character before the dollar sign is capital O.

Thanks to Bob Liddil, Scott Adams, and several other BYTE readers for calling these problems to our attention.



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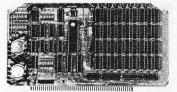
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Technical Forum

An ADM-3 Emulator for the Hazeltine 1500

Charles Shoemaker 2725 E Maplewood Ave Littleton CO 80121

All Hazeltine 1500 owners seem to agree on two things: it is a very nice terminal; and they are frustrated that a good deal of the software available that uses cursor control has been written for the Lear Siegler ADM-3 terminal; consequently, it will not run properly on the 1500.

In my particular case, the problem came to a head as I was attempting to modify for my terminal a graphics game written in 8080 assembly language. Some of the cursor-movement control was not at all obvious, and I wasn't really willing to take the time to follow the entire structure of the program through just to play a simple game.

This, coupled with the fact that I'd have to do the same (disassembling system software where no source code is provided) for every program written for the ADM-3, led me to write this routine.

This routine is a patch to my CP/M operating system BIOS (I/O driver module). It can be placed in ROM (read-only memory) or programmable memory, but, if it is placed in ROM, the two temporary locations, MODE and Y, will have to be relocated somewhere in programmable memory. The routine is entered with the ASCII (American Standard Code for Information Interchange) character to be sent contained in the C register and the parity bit low. It assumes that the output status has been checked and that the output port is ready for a character. Registers A and C are altered on exit. Since this routine needs to send as many as four characters (I will explain that in a moment), there's a subroutine to wait for output status, which will have to be customized for other systems.

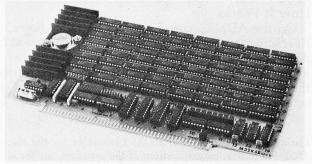
If the character to be sent comes in another register, the MOV instructions to and from C (and the PUSH B and POP B instructions, if the register is B) can be easily altered. For example, if the program sends the character in A, the following routine can be used:

PUSH B MOV C,A CALL EMULATOR POP B RET

Note that in the 8080 instruction set, the PUSH B and POP B instructions also do the same to C.

The code is twisty, and a little bit devious, as described below. I first attempted to fit it into 128 bytes, so that it would fit in one disk sector. Unfortunately, I didn't quite make it. Users with Z80 processors can take advantage of

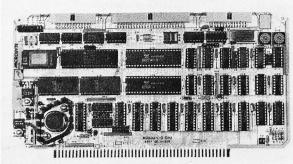
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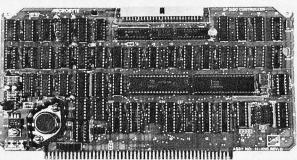


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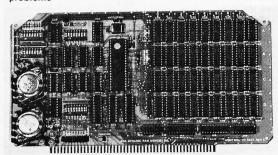
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Technical Forum.

their relative-jump capabilities and easily crunch it into 128 bytes.

How It Works

On the ADM-3, cursor up, cursor right, home, and clear screen are simple control codes: 11, 12, 30, and 26 in decimal, respectively. The control codes for the two terminals are shown in table 1. These codes are converted in the routine called NORM (see listing 1). Noncontrol characters are shunted to be transmitted directly at the label

Listing 1: The Lear Siegler ADM-3 emulator for the Hazeltine 1500. For a detailed explanation of the program, see the accompanying text.

	ORG JMP	7FB4H ENTRY	; FIX CPM OUTCH ROUTINE TO JUMP HERE
	ORG	8000Н	; PUT AFTER BIOS
ENTRY:	LDA ORA	MODE A	; ARE WE IN THE MIDDLE OF SOMETHING?
	JZ JZ	A,C NORM	; GET CHARACTER TO SEND, FOR COMPARES ; ORDINARY
	JPE	XY	; IF JUMP TAKEN, NORM CONTAINS EITHER 3 OR 255
	CPI	/= / ·	; MIDDLE OF XY ADDRESS SEQUENCE
	MVI STA	A,O MODE	; PRESET ERROR CONDITION
	JNZ	ZAP A,3	; SOMETHING'S WRONGPRINT IT AND GIVE UP ; FIX UP
	STA	MODE	; TELL US NEXT TIME
NAME OF TAXABLE PARTY.	RET		
NORM:	CFI JC	30 NTHOME	; TEST FOR HOME CHARACTER
	JNZ	ZAP C,18	; NOT A CONTROL CHARACTERSEND IT ; GET HAZEL'S HOME CHARACTER
ALTHOME +	JMP	SPECL	; DO IT
NTHOME:	CPI JZ	11 SPECL-1	; IS IT UP-CURSOR? ; QUICK TRICK
	CPI JNZ	12 NTRGHT	; IS IT RIGHT-CURSOR? ; NO
	JMP	A,16	; HAZEL'S RIGHT-CURSOR
NTRGHT:	CPI JNZ	27 NTESC	F IS IT ESCAPE-ADDRESS CURSOR?
	MUI	A,1	; TELL US NEXT TIME THROUGH
	STA RET	MODE	
NTESC:	CPI	26	; IS IT CLEAR SCREEN?
	JNZ INR	OUTCH C	; IS IT CLEAR SCREEN? ; NO, MUST BE SOME OTHER CONTROL CHARACTER ; MAKE 28, HAZEL'S CLEAR SCREEN CHARACTER
005014	INR	C	
SPECL:	CALL	A+126 ZAP	# GET HER ATTENTION # SEND THE FIRST CHARACTER RIGHT AWAY
OUTCH:	MOV PUSH	A,C PSW	; RETRIEVE ORIGINAL CHARACTER ; STOW IT AWAY
	IN ANI	10H	; GOTTA CHECK STATUS
	JZ POP	OUTCH+2 PSW	; GET IT BACK
ZAP:	OUT	11H	; SEND IT
	RET		; FINALLY, RETURN TO CALLER
XY:	JM	FINAL	; WE KNOW WE HAVE 'ESC' '=' SEQUENCE ; SEE IF THIS IS X OR Y CHARACTER
	моч	A.C	; TAKE THE JUMP IF THIS IS X ; JUST GET Y CHARACTER
	STA	Υ	; AND SAVE IT
	MVI STA	A,OFFH MODE	; LET US KNOW WHAT TO DO NEXT TIME
	RET		; AND BACK
FINAL:	FUSH MUT	B C,17	; SAVE X CHARACTER A MINUTE ; GET HAZEL'S ATTENTION
	CALL	SPECL	
	MOV	A,C	; GET'M BACK ; GET X COORDINATE ; GET RID OF ADM-3 BIAS
	CPI	32 31	FIX HAZEL'S BIAS
	JNC	SENDX 96	; OK AS IS ; HAZEL LIKES THIS BETTER
SENDX:	CALL	OUTCH+1	F SEND X
	STA	A MODE	, is note of proxime
	LDA JMP	Y OUTCH+1	; ADM-3 BIAS OK FOR HAZEL ; SEND IT AND GO HOME
MODE:	DB	0	
Y:	DB	0	
	END		

A>

dBASE II vs. the Bilge Pumps.

by Hal Pawluk

We all know that bilge pumps suck.

And by now, we've found out—the hard way—that a lot of software seems to work the

same way.

So I got pretty excited when I ran across dBASE II, an assembly-language relational Database Management System for CP/M. It works! And even a rank beginner like myself got it up and running the first time I sat down with it.

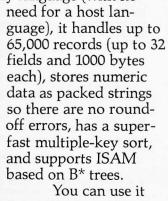
If you're looking for software to deal with your data, too, here are some tips that will help:



dBASE II vs. everything else.

dBASE II really impressed me.

Written in assembly language (with no



You can use it interactively with English-like commands (DISPLAY 10 PROD-UCTS), or program it

(so when you've set up the formats, your secretary can do the work). Its report generator and user-definable full screen operations mean that you can even use your existing forms.

And if all this makes your mouth water, but you've already got all your data on a disk, that's okay: dBASE II reads your ASCII files and adds the data to its own database.

Right now, I'm using **dBASE II** with my word processor for budgeting, scheduling and preparing reports for my clients.

Next come job costing, time billing and accounting.

Tip #1: Database Management vs. File Handling:

Any list or collection of data is, loosely, a data base, but most of those "data base management" articles in the buzzbooks are really about file handling programs for specific applications. A real Database Management System gives you data and program independence (no reprogramming when data changes), eliminates data duplication and makes it easy to turn data into information.

Tip #2: Assembly Language vs. BASIC:

This one's easy: if you're setting up a DBMS, you're going to be doing a lot of sorting, and Basic sorts are s-l-o-w. Run a benchmark on a Basic system like S*-IV against a relational DBMS like **dBASE II** and you'll see what I mean. (But watch it: I've also seen one extremely slow assembly-language file management system.)

Tip #3: Relational vs. Hierarchal & Network DBMS.

CODASYL-like hierarchal and network systems, around since the 1960's, are being phased out on the big machines so why get stuck with an old-fashioned system for your micro? A relational DBMS like **dBASE II** eliminates the predefined sets, pointers and complex data structures of a CODASYL-type DBMS. And you don't need to be a programmer to use it.

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HOST → TARGET

Technical Forum.

Action ADM-3

11 (Control-K) Cursor Up Cursor Down 10 (line feed)

126, 12 (~, Control-L)

H-1500

10 (line feed) Cursor Left 8 (backspace) 8 (backspace) Cursor Right 12 (Control-L) 16 (Control-P)

Clear Screen 26 (Control-Z) 126, 28 (~, Control-shift-L) Cursor Home 30 (Control-shift-N) 126, 18 (~, Control-R)

Table 1: The control codes for the Lear Siegler ADM-3 and the Hazeltine 1500 terminals. The numbers are the decimal values for the ASCII codes shown in parentheses.

ZAP. The control codes are detected with a series of compare operations, and the proper code for the Hazeltine placed in the C register. The Hazeltine's 126 functionlead-in code is sent, if necessary, by the jump to SPECL. Other control codes (carriage return, line feed, backspace, etc) fall through and are sent unchanged.

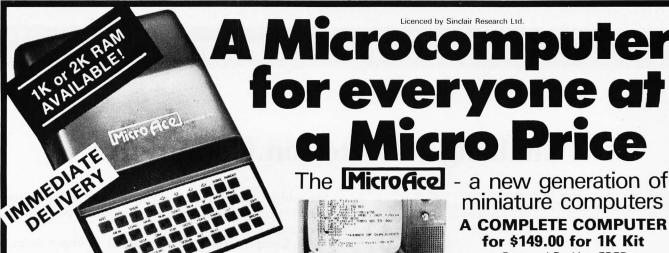
The two-coordinate direct cursor addressing is more complicated. For both terminals, X is the horizontal position, from 0 thru 79, and Y is vertical, from 0 thru 23. The ADM-3 must receive the sequence ESC (ASCII 27), "=" (ASCII 61), Y + 32, and X + 32. The H-1500 requires the tilde (\sim , ASCII 126), ASCII 17, then X, then Y+32. In addition, if X is in the range 0 thru 31, then 96 should be added, although the terminal will accept 0 thru 31.

The routine collects all four characters from the host software, then sends the Hazeltine control sequence. Since the emulator is called four times before it can complete the direct-cursor addressing sequence, we need some way to know where we are in the sequence and what action needs to be taken in each case. The temporary byte, MODE, is the key to what happens. Its four states are as follows:

- MODE=0: We are not in the middle of a directcursor-address sequence. NORM gets control. If NORM detects ESC, it sets MODE to 1 and returns.
- MODE=1: ESC has been detected. If "=" is the current character, MODE is set to 3 and the routine returns. Otherwise, MODE is reset to 0 and the character is sent.
- MODE=3: This character is the Y coordinate. The byte is stored in variable Y, and MODE is set to 255.
- MODE=255: The byte to be sent is the X coordinate. The byte is processed for the Hazeltine and the lead-in and control bytes are sent. X is recovered and sent, then Y is recovered. No processing for the 1500 is needed here. MODE is reset to 0 and Y is transmitted.

These values for MODE were chosen so that a fourway branch could be taken from one test, the ORA A instruction at the top of the routine. The zero flag is tested first, and the jump-on-zero instruction branches to NORM. The 1 condition is separated by the JPE, as it is the only condition with odd parity. The 3 and 255 are differentiated with the sign flag.

The kind of multiway branching I've used here is worth a little study. It could be useful in a number of applica-



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Technical Forum

Challenger Writes on Comprint

Edward H Carlson, 3872 Raleigh Dr, Okemos MI 48864

I use an Ohio Scientific C2-4P for word processing and text editing. I selected the Comprint 912 as a printer because of its legibility (9 by 12 dot matrix), speed (3 lines per second), quietness (electrostatic printing, not impact), and low cost. The choice of the parallel-interface model reduced costs further. I want to show you a 6502 assembly-language program that interfaces a 6522 VIA (versatile interface adapter) parallel port to the Comprint 912.

The Model 500 main processor board of an OSI Challenger II has a provision for a 6820, a 6520, or a 6521 PIA (peripheral interface adapter) containing two 8-bit parallel ports. The 6522 VIA enhances the PIA functions with extra handshake options and two timers. I had already added a 6522 to my processor board in the space for the PIA. A little extra work was required because six pins have different functions on the 6522. I made the modification by changing only four lines on the Model 500 processor board. The price was a nonstandard naming of the address lines to the sixteen registers of the 6522.

The address conversions needed are noted at the bottom of listing 1. The 6522 resides at hexadecimal location F7xx in memory.

The Comprint has several parallel I/O (input/output) options. I've used the wide strobe/acknowledge mode, enabled by pulling a jumper pin from the Comprint circuit board. Besides the seven lines of ASCII (American Standard Code for Information Interchange) data, there are three control lines. DAV is the strobe signal sent by the computer telling the printer that valid data is on the data lines. NDAC is the acknowledge signal sent by the printer telling the computer that the data has been accepted. NRFD is the busy line that the printer sets high when its data buffer is full and unable to accept further data.

At the 6522 end, the lines are assigned as follows: DAV is CB2, put high and strobed low when the 6502 processor writes data to port B of the 6522 VIA. It must be set high again before the next ASCII character is sent. NDAC is CB1, configured to detect the trailing edge, low-to-high transition, of the acknowledge signal sent from the printer. NRFD is pin PB7 of the eight-line parallel data. One wants to detect the high or low state of this line, not an edge as it makes a transition.

Listing 1: After installing the 6522 VIA in the Model 500 processor board of the OSI Challenger II, this 6502 assembly-language program interfaces the 6522 parallel port to the Comprint 912.

10 C000		* = \$C000		
20 C000	;		PARALL	EL PORT TO COMPRINT 912
30 C000 48	OUTCHR	PHA		A CONTAINS CHARACTER
40 C001 A902		LDA #\$02		ENABLE B PORT OF 6522
50 C003 8D0EF7		STA \$F70E		
60 C006 A97F		LDA #\$7F		DATA DIRECTION
70 C008 8D08F7		STA \$F708		
80 C00B 8D07F7		STA \$F707		CLEAR INTERRUPT FLAGS
90 C00E A990		LDA #\$90		READY STROBE, PERIPHERAL CONTROL
100 C010 8D03F7		STA \$F703		CB1 TO GO LOW ON WRITE, DAV
110 C013 AD00F7	BUSY	LDA \$F700		READ B PORT INPUT
120 C016 2980		AND #%1000000	00	BIT 7 IS NRFD OF COMPRINT
130 C018 30F9		BMI BUSY		BUSY IF BIT 7 IS HIGH
140 C01A 68		PLA		
150 C01B 49FF		EOR #\$FF		INVERT, DATA ACTIVE LOW
160 C01D 8D00F7		STA \$F700		OUTPUT TO PRINTER
170 C020 AD07F7	ACK	LDA \$F707		LOOK FOR NDAC ON CB2
180 C023 2910		AND #\$10		NDAC IS ACKNOWLEDGE FROM
190 C025 C910		CMP #\$10		COMPRINT
200 C027 D0F7		BNE ACK		IF NOT FOUND, LOOK AGAIN
210 C029 A9F0		LDA #\$FO		RESTORE CB1 TO HIGH, END DAV
220 C02B 8D03F7		STA \$F703		
230 C02E 60		RTS		
235 C02F	;		Standard	Mine
240 C02F	; B Port I/C		00	00
250 C02F		Control Register	OB	OE
260 C02F		Control Register	0C	03
270 C02F	; Interrupt l	Flag Register	0D	07

Volume II Ciarcia's Circuit Cellar

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311

Technical Forum,

The subroutine to write one character to the printer is given in the listing 1. When called, accumulator A contains the character to be sent. The Comprint expects inverted data (ie: 1 to be low and 0 to be high). A hardware modification can be made to the Comprint 912 to accept noninverted data, but I elected to do the inversion in software with an exclusive-OR (XOR) instruction.

First, port B is enabled. Then data lines PB0 thru PB6 are assigned to output the ASCII character, and data line PB7 is assigned to input the busy signal. The interrupt-flag register is cleared (by writing 1s to it) so that it can detect transitions in CB1.

Next, a mask is written to the peripheral control register, which does two things:

- 1. requests an interrupt flag to be set for low-to-high transitions of the acknowledge line CB1;
- 2. requests CB2 to go low when the processor writes to

the 6522, to make the beginning of the strobe signal DAV.

Port B is now ready to see if PB7 is high, denoting a busy signal. If not, the data is sent and the interrupt-flag register is repeatedly read to await the acknowledge signal before continuing. (Bit 4 is set by an active transition of CB1, not bit 3 as given in the old edition of the Osborne and Associates book *An Introduction to Microcomputers*.) This flag is reset by the next write to Port B.

Finally, the DAV line is set high again, to end the wide strobe pulse, and the subroutine is exited.

Some options that could be tried are: use of the *narrow-strobe/acknowledge* mode of the Comprint 912, use of port A of the 6522, or use of a PIA instead of the VIA. In each case, the program would need modifications.

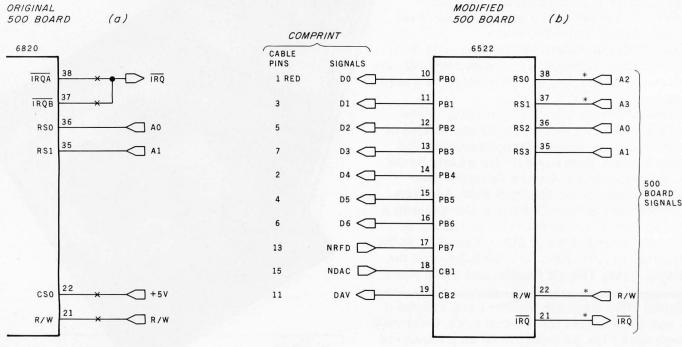


Figure 1: The hardware modification that enables the Comprint 912 printer to work with the OSI Challenger II. When the 6820 position on the Model 500 processor board is modified to take the 6522 VIA, the four marked lines must be cut (the lines to pins 21, 22, 37, and 38, see figure 1a). New lines must be attached to these pins (denoted by asterisks in figure 1b). Note the nonstandard address-line assignments after the rewiring is completed.

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On the Use of Fourier Transforms to Explore **Biological Rhythms**

A J Owens, Bartol Research Foundation, University of Delaware, Newark DE 19711

In his editorial "Is Pseudoscience Done by Computer Pseudo-Computer-Science?" (November 1979 BYTE, page 6), Carl Helmers encouraged the analysis of numerical data to test the validity of the biorhythm hypothesis: that our lives are dominated by a few quasisinusoidal cycles. He suggested taking data on our personal lives, perhaps rating each day on a scale of 1 to 10, and then analyzing the time series using the fast Fourier transform (FFT).

Coincidentally, motivated by some biorhythm proponents in an introductory astronomy class that I was teaching, I have been carrying out exactly that program since January 1977. Through November 1979, my data set consisted of 1024 consecutive daily ratings of my personal well-being, recorded by me each evening on a scale of 1 to 10.

While reading Mr Helmers' editorial, I decided to program my AIM-65 microcomputer to analyze the data. (I had previously analyzed 256- and 512-day subsets of the data as they became available, using a FORTRAN program run on a minicomputer.)

With only 4 K bytes of user memory, my AIM-65 could barely run the program to analyze 256 data points

About the Author

A J Owens is a research physicist and professor at the Bartol Research Foundation of the Franklin Institute, which is located at the University of Delaware. He received his postgraduate degrees from the California Institute of Technology in the field of theoretical physics. Although he uses mainframe computers for his astrophysical research, he claims to be a novice in dealing with microcomputers, having graduated downward from time-sharing systems and minicomputers. He currently uses a Rockwell AIM-65 linked to a BETA-1 digital cassette system.

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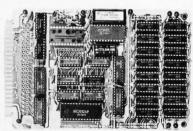
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Technical Forum

—in fact, the comments had to be deleted to fit the program into the memory. The FFT algorithm used here was originally written for a Digital Equipment Corporation time-sharing computer, and the only modifications are the small input routine and the calculation of the power spectrum at the end. The fast Fourier transform routine for 256 data points takes about 3 minutes to run.

It is of crucial importance in any time-series analysis to understand (and report) details concerning the statistical uncertainty in the results that are obtained. Otherwise, the importance of an insignificant wiggle in the Fourier transform at the "right" place can be blown far out of proportion. Fortunately, information scientists have studied the problem of extraction of signals from noise, and the basic concepts are not too difficult to grasp. For a complete (and technical) account, I suggest reading *Random Data: Analysis and Measurement Procedures*, by J S Bendat and A G Piersol (Wiley-Interscience, New York, 1971).

Suppose that you begin with N data points, each a sample from some process that is random or noisy. Obviously, no matter how you "massage" the data, you have only N independent samples. In the fast Fourier transform, the N data points sampled at intervals of time separated by $\triangle t$ are transformed into N Fourier coefficients in the frequency domain, one each for the sine and the cosine terms corresponding to frequencies $1/N\triangle t$, $2/N\triangle t$, . . . , $(N/2-1)/N\triangle t$, $1/2\triangle t$. For random data, the Fourier coefficients have random phases, so one usually reports the power spectrum, which is the sum of the squares of the sine and the cosine terms (altered by a multiplication constant used to normalize the result). The original N data points give N/2 power spectral estimates in frequency space, each with two degrees of freedom one each from the sine and cosine terms.

Inasmuch as each raw-power spectral-density estimate has only two degrees of freedom, it is rather poorly determined. In only two-thirds of the cases can one expect the "true" power spectral level to be in the interval between zero and two times the measured power spectrum.

To improve the accuracy of the estimates, one averages the power spectrum. One method of doing this, the one that I applied, is to divide the total data set into smaller groups of points, calculate the power spectrum for each subset, and then average the power spectra from each group. For example, my set of 1024 days was divided into four groups of 256 points each. Power spectra for each of the four groups were calculated, and the resulting four spectra were averaged at each of the 128 power spectral points in frequency space.

A second approach is to calculate the power spectrum of the entire record (eg: 1024 days). One then averages the several adjacent frequency bins (eg: four) to get a smaller number of more accurately known power spectral estimates.

In either case, averaging four spectra (or frequency bins), each with two degrees of freedom, gives power spectral estimates with eight degrees of freedom. As a result, we expect that, in two-thirds of the cases, the "true" power spectrum at a given frequency will then lie between 0.5 and 1.5 times the measured value. In general, the fractional uncertainty in each estimate is $\pm\sqrt{(2/D)}$,







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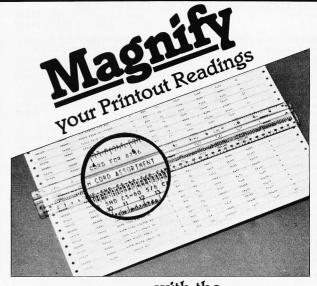
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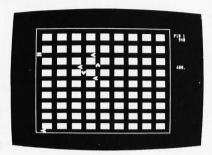
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Technical Forum_

where *D* is the number of degrees of freedom.

The BASIC computer program shown in listing 1 is quite simple. The routine in lines 100 thru 180 allows the data to be entered. Because the input data are real (ie: they have no imaginary component), they are stored in the one-dimensional array X, and the one-dimensional

Listing 1: Power spectrum calculation program. This program was used to calculate the data points plotted in figures 1 and 2.

```
PROGRAM FETPOW
2 REM
                       POWER SPECTRUM USING FFT
                       A. J. OWENS 16-NOV-79
REAL PART OF FUNCTION IN X, IMAG IN Y
3 REM
6 REM
10 DIM X(256),Y(256)
                      INPUT ROUTINE GIVES DATA X AND Y AND NUMBER OF DATA POINTS, N, A POWER OF 2. INPUT ROUTINE IS IN LINES 100-199. FFT CALCULATION ROUTINE IS IN LINES
25 REM
27 REM
29 REM
30 REM
                       200-590. PRINTOUT OF THE POWER SPECTRUM
IS IN LINES 591-800.
INPUT ROUTINE
32 REM
34 REM
100 REM
150 N=256
160 FOR I=1 TO N
170 INPUT X(I)
175 Y(I)=0
180 NEXT I
200 REM BEGIN FFT CALCULATION
202 G=INT(LOG(N)/LOG(2)+1.00000E-06)
203 P=2*3.14159/N
204 FOR L=0 TO G-1
206 G1=2^(G-L-1)
208 M=0
210 FOR I=1 TO 2°L
220 K1=INT(M/G1)
230 GOSUB 530
240 Y1=COS(P*K2)
250 Y2=-SIN(P*K2)
260 FOR J=1 TO G1
270 Y3=X(M+G1+1)*Y1-Y(M+G1+1)*Y2
280 Y4=X(M+G1+1)*Y2+Y(M+G1+1)*Y1
290 X(M+G1+1)=X(M+1)-Y3
300 Y(M+G1+1)=Y(M+1)-Y4
310 X(M+1)=X(M+1)+Y3
320 Y(M+1)=Y(M+1)+Y4
330 M=M+1
340 NEXT J
350 M=M+G1
360 NEXT I
370 NEXT I
380 FOR I=0 TO N-1
400 GOSUB 530
410 IF K2>=I THEN 480
420 K3=X(I+1)
430 X(I+1)=X(K2+1)
440 X(K2+1)=K3
450 K3=Y(I+1)
460 Y(I+1)=Y(K2+1)
470 Y(K2+1)=K3
480 NEXT I
499 GO TO 591
500 REM STATEMENTS 500 TO 510 PRINT DUT RESULTS
501 REM OF THE FFT ITSELF; SKIPPED HERE
502 FOR I=0 TO N-1
504 PRINT I;X(I+1); '+I';Y(I+1)
506 NEXT I
520 GO TO 591
530 K2=0
540 FOR K=1 TO G
550 K3=INT(K1/2)
560 K2=2*(K2-K3)+K1
570 K1=K3
580 NEXT K
590 RETURN
593 PRINT 'STEP BETWEEN DATA POINTS';
595 INPUT T
591 REM PRINT OUT POWER SPECTRUM
599 PRINT
             'NUMBER OF POINTS AVERAGED';
600 INPUT M
605 PRINT
610 PRINT ' FREQUENCY
620 Q=2*T/(M*N)
630 FOR J=0 TO N/2 STEP M
640 S=0
650 FOR I=1 TO M
660 S=S+Q*(X(J+I+1)*X(J+I+1)+Y(J+I+1)*Y(J+I+1))
670 NEXT I
680 F=(2*J+M)/(2*N*T)
690 PRINT F,S
700 NEXT J
800 GO TO 599
```

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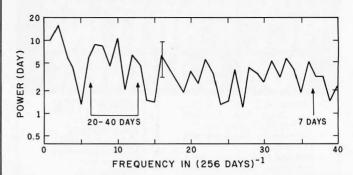


Figure 1: A power spectrum chart averaging four periods of 256 days each. This figure of the low end of the full-power spectrum graph shows the relative intensities of sine waves of various frequencies. The range of values bracketed by the arrows labeled "20-40 days" represents the power of sine waves with periods between 20 and 40 days. If biorhythms were present in this power spectrum, they would have appeared as significant peaks at certain points within this range. The vertical line at frequency = 15 shows the possible variation of the point on the graph and is a measure of the possible error in measurement at that point.

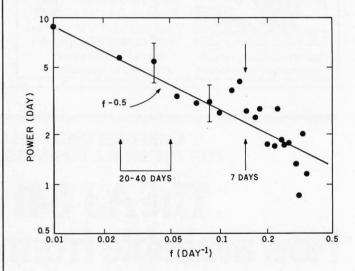


Figure 2: A modified power spectrum chart. The data of figure 1 was averaged over four frequency bins, giving a more accurate set of data points, and plotted using logarithmic scales for both the frequency and power axes. The notation used is described in the caption for figure 1.

array Y is set to zeros. Lines 200 thru 590 perform an *N*-point fast Fourier transform:

$$F_n = \sum_{k=0}^{k=N-1} Z_k \exp(-2\pi i k n/N)$$

where $Z_k = X_k + iY_k$ is the (complex) input vector and F_n is the complex Fourier transform ($i = \sqrt{-1}$ and is the unit measure along the imaginary axis when dealing with complex numbers). The real (cosine) part of F is placed in X and the imaginary (sine) part in Y by the routine. The nth frequency, corresponding to the Fourier coefficient F_n , is $f_n = n/(N \triangle t)$. The power spectrum is calculated in

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Frequency in (256 days) ⁻¹	log₁₀ (Power)
1 2 3 4 5	1.00 1.20 0.83 0.59 0.10
6 7 8 9 10	0.76 0.94 0.91 0.61 1.00
11 12 13 14 15	0.29 0.79 0.65 0.16 0.13
16 17 18 19 20	0.79 0.62 0.44 0.26 0.56
21 22 23 24 25	0.39 0.73 0.52 0.12 0.17
26 27 28 29 30	0.58 0.08 0.62 0.53 0.42
31 32 33 34 35	0.72 0.47 0.74 0.57 0.27
36 37 38 39 40	0.70 0.48 0.49 0.12 0.49

Table 1: Table of values for the power spectrum chart of figure 1. The second column of numbers is the base-10 logarithm of the value of the power. For example, for point 20, $10^{0.56}$ equals 3.63, which is the value plotted in figure 1 at the point frequency =20. The marks for 7, 20, and 40 days in figure 1 correspond to frequency values (with units of (256 days)⁻¹) of 36.6, 12.8, and 6.4, respectively. The logarithm of the variation of the error mark at frequency = 16 is +0.18 and -0.30 from the recorded value of 0.79.

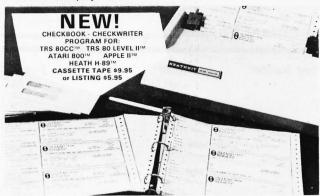
lines 591 thru 800, using the relation:

 $P_n = (2\triangle t/N)|F_n|^2$

The program allows averaging of the power over any specified number of frequency bins. If M frequency estimates are averaged, the number of degrees of freedom in the single power spectrum is D=2M and the fractional statistical uncertainty is $\pm\sqrt{(2/2M)}=\pm\sqrt{(1/M)}$.

As mentioned above, I scored 1024 consecutive days on a scale of 1 to 10 and analyzed the data in 256-day groups. The average scores for the four groups were 5.1, 4.6, 4.5, and 4.6, indicating a mean near 5 with a hint of a long-term decline. The day-to-day variation (standard deviation) was close to 1 for each of the four periods.

Averaging the power spectra for the four periods, I ob-



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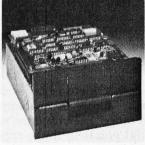
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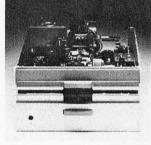
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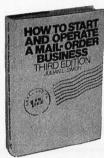
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6 7 8 9	-1.06 -0.99 -0.92 -0.87 -0.82	0.50 0.43 0.55 0.61 0.42
11	-0.78	0.39
12	-0.74	0.45
13	-0.70	0.24
14	-0.67	0.22
15	-0.64	0.45
16	-0.61	0.26
17	-0.59	0.24
18	-0.56	0.24
19	-0.54	0.11
20	-0.51	-0.07
21	-0.49	0.30
22	-0.47	0.06

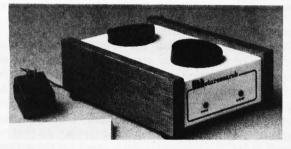
Table 2: Table of values for modified power spectrum of figure 2. Here, both columns of numbers are the base-10 logarithms of their respective values as plotted in figure 2. For example, for point 2, $10^{-1.80}$ and $10^{0.78}$ give values of 0.025 and 6.026, which can be read off the horizontal and vertical axes of figure 2. The marks for 7, 20, and 40 days in figure 2 correspond to frequency values (with units of $(days)^{-1}$) of 0.141, 0.050, and 0.025, respectively. The logarithm of the variation of the error mark as shown in figure 2 is +0.10 and -0.12.

tained the power spectrum, the low-frequency part of which is shown in figure 1. Note that the power spectrum's vertical axis is logarithmic; this makes the size of the statistical uncertainty in each point the same. A typical error flag at *frequency* = 15 is shown. A few relevant cyclic periods are shown, including the week (seven days) and the canonical biorhythm periods (twenty to forty days).

The safest thing to say is that there is no evidence whatsoever for enhancements above the background noise level in the biorhythm range. Even if all the variation in the six power spectral points in the twenty- to forty-day range is attributed to biorhythms, the contribution is only about fifteen percent of my total variance from day to day. But there is no evidence for any periodicities in this region, and the noise in the biorhythm range looks similar to that at both lower and higher frequencies.

The perceptive reader may notice that the power spectrum shown in figure 1 is not flat, as would be the case for perfectly "white" or uncorrelated noise. This implies that there is some temporal structure in my day-to-day feeling of well-being. To investigate this more closely, I averaged the data in figure 1 over four adjacent frequency bins, to give power spectra with thirty-two degrees of freedom. The results are shown in figure 2, given as a log-log plot. The solid line shows that the power spectrum is well fit by a power law spectrum, $P(f) \propto f^{-0.5}$. This is an unusual power spectrum. White noise has a flat spectrum, and random-walk noise has a f^{-2} spectrum. Electrical "flicker

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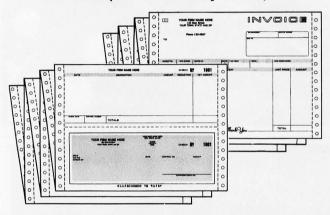
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Technical Forum.

noise" has an f^{-1} spectrum. My biorhythms, instead of producing quasi-periodic "music of the spheres," seem to be more in the nature of a slightly colored and unique random hiss!

Biorhythms and Fourier Transforms

Proponents assert that the relative strength and weakness of mankind in areas roughly described as "physical," "emotional," and "intellectual" vary in cycles of twenty-three, twenty-eight, and thirty-three days, respectively, with each of the curves approximating sine waves of equal amplitude. Of course, the effects of each influence are added together, so that an overall index of a particular day's merit (as the author recorded by assigning each day a number between 1 and 10) would not readily show the presence (or absence) of these sinusoidal waves.

This is where Fourier transforms (either fast or discrete) come in. In theory, any complex periodic waveform can be shown to be the sum of a number of sine waves of differing frequencies and amplitudes. The Fourier method transforms an amplitude-versustime waveform into its equivalent amplitude-versusfrequency waveform—ie: the transformed waveform tells the relative strengths of the different frequency sine waves that, when added together, will give the original amplitude-versus-time waveform.

Once this is understood, it becomes apparent that, if a specified waveform contains definite twenty-three-, twenty-eight-, and thirty-three-day cycles, these cycles should cause visible peaks in the appropriate places on the frequency (horizontal) axis of the transformed waveform. The lack of such peaks would indicate that these frequencies contribute no more to the overall waveform than other frequencies do. A transformed wave that is roughly a flat horizontal line indicates that sine waves of all frequencies contribute equally to the original waveform. Such a waveform has no dominant frequencies. A signal consisting of random components with no discernible dominant frequencies is known as white noise.

Another verification of the transformed wave is concerned with the amplitude of existing peaks. In this situation, those peaks that correspond to the biorhythm cycles should be of equal amplitude, because the three biorhythm cycles are defined as being of equal amplitude.

Response by Carl Helmers

This article suggests an approach to verification of any biological cycles hypothesis. It is not a controlled scientific experiment, and any conclusions are thus applicable only to this particular individual's characteristics.

By applying techniques of signal analysis to a broader population of individuals, it might be possible to design a scientifically valid experiment.

References

Bendat, J S, and A G Piersol, *Random Data: Analysis and Measure-ment Procedures*, Wiley-Interscience, New York NY, 1971. Stanley, W D, and S J Peterson, "Fast Fourier Transforms on Your Home Computer," December 1978 BYTE, pages 14 thru 25.

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Ask BYTE

Conducted by Steve Ciarcia

4116 Pointers

Dear Steve,

Being an ardent do-it-yourselfer, I'm currently in the process of designing a homebrew computer system. Since the 16 K-bit type-4116 dynamic memories are cheap, compact, and use little power, I have decided to use them as my main memory components. Designing the interface is no problem, but I'm all too aware of the 4116's cantankerous nature with respect to circuit-board layout, power-supply fluctuations, and so forth. What should I know about these devices? Ken McDonald

The most important thing to remember when designing any computer that uses 4116s is that the power-supply volt-

Yellowknife, NWT, Canada

ages have to be turned on and off in sequence. To keep from blowing the 4116 on powerup, the -5 V supply must be turned on before the +5 V and +12 V supplies. On power-down, the -5 V has to remain on while the +5 and +12 are removed.

In lower-current power supplies (such as you will probably use), the sequencing can be accomplished through the time constants of the power supply itself; this technique is used in the TRS-80. By giving the -5 Vsection a very fast time constant compared to the other two supplies, it appears to come on first. On powerdown, the sequence is reversed. Because the -5 V has such a low-current draw on it, it will stay up long after the other voltages have dropped.

Other than that, use prime components and stay away from surplus devices. For more information on refresh timing signals of dynamic memories, refer to my article in the March 1981 BYTE "Build the Disk-80: Memory Expansion and Floppy-Disk Control," on page 36....Steve

Any Port in a Storm

Dear Steve,

I'm not sure if I understood the little that I read of your article "I/O Expansion for the TRS-80, Part 2: Serial Ports." (See the June 1980 BYTE, page 42.) Can I use the modem on my Radio Shack RS-232C port and my serial (Diablo) printer on your RS-232C port or vice versa? If so, are there any tricks to it?

via The Source

You say that you already have an RS-232C interface, so I'll presume it is Radio Shack's TRS232, which is installed inside the TRS-80 Expansion Interface. Normally, only one interface can be accommodated, and it is hardwire-addressed as port hexadecimal E8. Because the COMM-80 has selectable addressing, it can be added to your system and set for one of fifteen other addresses. With a software driver that directs any output to this second serial port, you can plug your Diablo into it and use both ports without conflict.

What you really need is a CHATTERBOX, which is a COMM-80 with an acoustic modem installed in the same enclosure. It is designed so that, when the modem is in use, the characters being transmitted and received are



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sent out through the RS-232C connector. You can plug your Diablo directly into the CHATTERBOX and have a modem with a printer output. Absolutely no changes in any software are needed. ...Steve

TRS-80 Tape Formats

Dear Steve,

The TRS-80 has more software created for it than any other system. This software is usually transferred on a cassette that is readable only on

Table 1

Tape Formats

BASIC Tape Format 256 zeros followed by an A5 Leader sync byte D3 D3 D3 **BASIC** header Single-character file name LOB (low-order byte) Next line's address Pointer HOB (high-order byte) LOB Line number HOB ... XX Line contents XX 00 End-of-line marker 00 End-of-file markers 00 System Tape Format 256 zeros followed by an A5 Leader

Leader

System Tape Format

Sync byte

55 System-format header byte

System-format header byte

System-format header byte

System-format header byte

Achieved Pata header

Data header

Data length, 00 = 256 bytes

Loading

Address

Actual line contents

XX

Actual line contents

Checksum of line bytes and load address

78 End-of-file marker LOB Entry Address

Editor/Assembler
Source Tape Format

Leader

256 zeros followed by an A5
sync byte
Source header

XX XX XX XX XX XX File name
d1 d2 d3 d4 d5 5-digit line number in ASCII
(bit 7 is set)

20
XX ... XX
Data header
Line (128 bytes maximum)
End-of-line marker

End-of-file marker

BASIC Statement Storage
Format in Memory

Address of
HOB Address of
Next line
LOB Line number in
binary form
XX ... XX Line contents
00 End-of-line marker

1A

00 00

End-of-file marker



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VISA MASTERCHARGE a TRS-80. For people with other computers, this vast amount of software is unusable. Please tell me the data-storage format used by Tandy for its TRS-80.

Paul Shields

Victor Harbor, S A, Australia

Table 1 on page 329 shows the various TRS-80 Model I cassette-recording formats....Steve

Problem With Light Controls

Dear Steve.

It seems that a lot of BYTE readers are interested in home control via the BSR System X-10. I've fooled around with computerized home-control devices for some time, and I think BYTE readers should be aware of one rather distressing trait of the light-control modules.

When an incandescent bulb burns out, the filament in the bulb falls across its supports creating a momentary short circuit across the A C line. I have had three BSR units damaged when a bulb has gone out. Once it involved a single table lamp with a 70-watt bulb. Another time the failure occurred in a wall-switch module controlling my outdoor-perimeter circuit of 400 watts.

This seemingly practical and low-cost method of home control becomes something of a folly when you find that you must replace a \$16 control module because a \$0.69 bulb has burnt out. I have not been able to return modules for replacements, because the salespeople accuse me of overloading the module.

In the future, I hope that the design of these modules will include protection against the surge that occurs when a light bulb fails. Until then, I don't think they are all that practical and probably should not be committed to serious uses (for which they are advertised), such as a burglar deterrent. Chris Gundlach Huntington WV

I, too, have noticed that situation, and I've mentioned it to BSR. They are aware of the problem, but there isn't much that can be done to totally eliminate "zapping" the module except installing a 50 A triac (the cost would be prohibitive). There aren't too many ways to achieve foldback current-limiting in a triac.

Don't feel too bad. I've lost seven modules and a controller because of various problems, such as transients and blown bulbs. While the BSR unit is still cost-effective in consumer applications, I would be wary of it in critical control situations.

A few companies have asked me about using the BSR for industrial remote-control and solar-hearing systems, and I told them essentially what you have said to me. The application, of

course, determines the ultimate interface selection. When the alternative is a thousand-dollar computer front end, the BSR may still be the best choice—even if a receiver has to be replaced once in a while....Steve

The following is a letter sent to me concerning Mr Gundlach's problem, from BSR....Steve

BSR Responds to Criticism

Dear Mr Gundlach,

You are correct in your identification of the problem. All commercially available dimmers that contain triacs, as our lamp- and wall-switch modules do, are subject to zapping if a blown light-bulb filament falls in a "short circuit" position instead of open circuit.

Since the introduction of the System X-10 in the fall of 1978, all products have been updated and improved as necessary. We now use triacs



that we feel are most resistant to zapping. Our overall return rate is quite low, and has steadily decreased with respect to blown triacs. This is substantiated in part by the fact that the major retail chains continue to buy our products in large quantities and would not do so if there were persistent problems.

We are shipping you replacements for your failed units at no charge. I would greatly appreciate any feedback on performance that you care to give...good or bad!

Sorry you had some difficulties.

Peter A Lesser Vice President General Manager X-10 Division BSR Inc

The Two Can't Connect

Dear Steve,

I have an early (second year of production) Radio

Shack TRS-80 Model I 16 K-byte Level II computer that I'm having trouble adding peripherals to. I have a Quick Printer II, an Exatron Stringy Floppy, and a typewriter interface, each of which can be plugged into the expansion connector of the TRS-80 keyboard unit.

I also have a 1-into-2 cable that should allow me to use two peripherals at once. However, if more than one peripheral is plugged into the cable, the computer randomly executes the initial power-up routine—destroying whatever I was working on.

It doesn't seem to matter which peripherals I try to combine, nor does it matter if one is off. I don't think the problem is in the cable, because it works well with each of the peripherals singly and in either connection.

What could this be? I'd like to use the system for text processing, but that's impossible right now.

Ron Tye Long Beach CA The TRS-80 Model I sometimes does strange things when cables are connected to the keyboard. The longer the cables, the more likely the problem you described. With one peripheral installed, it may work properly, but when the load of another is added, the bus signals become sensitive to noise. Keeping the cables as short as possible helps.

The solution is to either add a circuit that buffers all

the signals from the keyboard or, at the very least, actively terminate the extension cable.

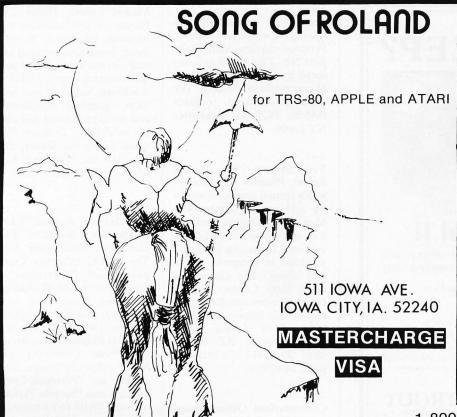
If you do not mind a little soldering, you can try terminating your present cable. At the end of the cable, from each signal, attach a 1 k-ohm resistor to +5 V and a 470-ohm resistor to ground. You'll have to add a separate 5 V supply, since +5 V is not available on the keyboard connector....Steve

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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April 1981

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April-October

Computer Sales-Marketing Workshops, various cities throughout the United States. These workshops are designed for retail salespeople and computer-marketing managers and their staffs. For a schedule of times and locations, contact Datasearch Inc, 4954 William Arnold Rd, Department C, Memphis TN 38117, (901) 761-9090.

April 1-2

Communications in the Twenty-First Century, Philip Morris Operations Center, Richmond VA. This conference will focus on technological advances and their economic, political, social, and psychological implications. Elie Abel, Professor of Communications at Stanford University, and Lord Briggs, provost of Worcester College, Oxford, England, are the keynote speakers. For information, contact the manager of Media Relations, Philip Morris Inc, 100 Park Ave, New York NY 10017.

April 1-3

Assuring Quality in Electronic Data-Processing Applications, McCormick Inn Hotel, Chicago IL. The objec-

tive of this conference is to explain the methods, tools, and techniques that are valuable in improving the quality of computerized applications. Tutorials cover the areas of quality assurance; managing structured design; and designing, implementing, and enforcing application standards. Contact DPMA Quality Assurance Conference, 12611 Davan Dr, Silver Spring MD 20904, (301) 622-0066.

Anril 3-5

The Sixth West Coast Computer Faire, Civic Auditorium, San Francisco CA. The Faire, a major personal-computing event, has continually attracted larger and larger numbers of exhibitors and attendees. A full program of talks plus a large display of hardware and software are featured. For more information, contact Computer Faire, 333 Swett Rd, Woodside CA 94062, (415) 851-7075.

April 4

The Third Annual RAMS Spring Computer Show, Perinton Square Mall, Fairport NY. This event is sponsored by the Rochester Area Microcomputer Society. For more information, contact RAMS, POB D, Rochester NY 14609.

Top Secrets '81, Pointe Resort, Phoenix AZ. Honeywell's annual computer security and privacy conference. Many data-security authorities will discuss the business and legal impact of the latest incidents in computer crime and abuse. The conference fee is \$500. Contact the Security Symposium Registrar, Honeywell Information Systems, M/S T-99-4, POB 6000, Phoenix AZ 85005, (800) 528-5343; in Arizona (602) 249-7954.

April 7-9

Computerized Office Equipment Expo-Midwest '81, O'Hare Exposition Center, Rosemont IL. This exposition has exhibits and seminars on the use of computers and related equipment in business environments. For details, contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago Il 60606, (312) 263-4866.

April 7-9

Electro/81. New York Coliseum and Sheraton Centre Hotel, New York NY. Electro/81 will feature computers and computer-related equipment, plus seminars on components, devices, and materials; computer communications; memories; office automation; speech; and more. Contact Electronic Conventions Inc, 999 N Sepulveda Blvd, Suite 410, El Segundo CA 90245, (800) 421-6816; in California (213) 772-2965.

April 9-12

Southwest Computer Show and Office Equipment Exposition, Market Hall, Dallas Market Center, Dallas TX. Hardware and software for business, education, government, home and personal use will be featured. Mini- and microcomputers, office machines, supplies and services, graphics equipment, and word processing will also be exhibited. Contact National Computer Shows, 824 Boylston St, Chestnut Hill MA 02167, (617) 739-2000.

April 10-11

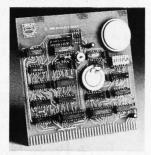
The Eleventh Annual VCUC Conference, Sheraton Red Lion Inn, Blacksburg VA. The VCUC (Virginia Computer Users Conference), a division of the ACM (Association for Computing Machinery), and the Computer Science Department of the Virginia Polytechnic Institute and State University are holding this conference. The themes are "Personal Computing" and "System Performance." Write to J Rosow or S Haldeman, VCUC 11, 562 McBryde Hall, VPI and SU, Blacksburg VA 24061.

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April 13-14

The Executive Computer Conference, Washington DC. The theme of this 2-day meeting is "Improving Organizational Productivity through Systems Technology." Special emphasis will be placed on management's perspective of the contributions the computer has made to organizational productivity. For information, contact Kendall E Burroughs, The Executive Computer Conference, 1730 N Lynn St, Suite 400, Arlington VA 22209, (703) 521-6209.

April 13-16

The Fifteenth International Symposium on Minicomputers and Microcomputers, MIMI '81, Sheraton Hotel, Mexico City, Mexico. The scope of this symposium covers hardware, software, distributed processor architecture, computer networks, telecommunications, real-time applications, education, and more. Contact Ing. Jorge Gil, Academic Secre-

tary, MIMI Symposium, IIMAS-UNAM, Apartado Postal 20-726, Mexico 20 DF, Mexico.

April 14-16

The Seventh Annual Federal DP Expo, Sheraton Washington Hotel, Washington DC. This conference and exposition is for computer-system users in the US government. More than 150 exhibitors and over 100 speakers will highlight the event. Contact The Interface Group, 160 Speen St, Framingham MA 01701, (800) 225-4620; in Massachusetts, call (617) 879-4502.

April 25-26

Trenton Computer Festival, Trenton State College, Trenton NJ. This annual flea market and swap meet of personal-computer equipment also features speakers, user-group meetings, and an exhibit of commercial products. It is sponsored by the Amateur Computer Group of New Jersey, the Philadelphia Area Computer Society, and

the Trenton State Computer Society. Contact TCF-81, Trenton State College, Trenton NJ 08625, (609) 771-2487.

April 26-30

Saudibusiness '81, Riyadh, Saudi Arabia. This show has been designed for the fastgrowing Saudi Arabian business community. Pavilions by the United States, the United Kingdom, West Germany, France, Italy, and approximately fifteen other countries will be featured. For more information, contact Donald Ryan, Project Manager, Rm 3200, US Department of Commerce, Washington DC 20230, (202) 377-4652.

April 27-30

National Design Engineering Show and Conference, Mc-Cormick Place, Chicago IL. The theme of this show is "Computers Throughout the Design Function." Additionally, the principal areas of consideration are design management, computeraided design, materials, mechanical components and systems, and electronics. Contact Clapp & Poliak Inc, 245 Park Ave, New York NY 10167, (212) 661-8410.

April 30-May 1

An Assessment and Forecast of Computer Graphics, Saddle Brook Marriott, Saddle Brook NJ. This annual conference will assess the present state of computer graphics and will evaluate hardware, software, systems services, and applications. The impact of new technologies on computer graphics and the role of graphics in business will be discussed. Contact Bob Sanzo, Frost & Sullivan Inc, 106 Fulton St, New York NY 10038, (212) 233-1080.

May 1981

May 2

National Computer Problem-Solving Contest for Iunior and Senior High School Students, throughout the US. Small teams of junior and senior high school students will compete for two hours on computer systems to solve five programming problems. Winners will be judged on whether their programs run properly using the test data supplied in the problem, are easy to read, and are logical, imaginative, and creative.

To receive a copy of the 1981 contest problems, local school directors should contact the University of Wisconsin-Parkside by April 4. Directors must agree to keep the problems confidential until the day of the contest. After that, any organization can use the problems to conduct its own contest. Local contest winners can enter the national and international contest. A national and worldwide ranking will be determined by a team of judges from the University of Wisconsin-Parkside. All interested schools or organizations can share the 1981 contest problems.

For additional information, write Dr Donald T Piele, Associate Professor of Mathematics, University of Wisconsin-Parkside, Kenosha WI 53141.

May 4-7

National Computer Conference, McCormick Pl, Chicago IL. Approximately 90,000 people are expected to attend this year's National Computer Conference (NCC). The use of robots and artificial intelligence will be among the program sessions at the Personal Computing Festival during the NCC. This will be the first time that personal-computing exhibits have joined the rest of the conference in the main exhibit area. Over thirty technical sessions will be held. All major companies will be represented. Contact the American Federation of Information Processing Societies Inc, POB 9658, 1815 N Lynn St, Arlington VA 22209, (703) 558-3617.

May 5-8

INTELCOM 81/Paris, Paris, France. INTELCOM (International Telecommunications and Computer Conference and Exhibition) 81/Paris is



part of a program to promote an international dialogue on vital subjects in the telecommunications field. This conference attempts to guide the evolution of the computer and its technology by combining the efforts of private companies, government, and equipment users. For information about attending, presenting a paper, or exhibiting at INTELCOM 81/Paris, contact the Conference Affairs Group, Horizon House, 610 Washington St, Dedham MA 02026, (800) 225-9977; in Massachusetts (617) 326-

May 11-13

Fourth Annual Rosen Research Personal-Computer Forum, Playboy Resort, Lake Geneva WI. This forum features guest speakers from all the major personal-computer hardware and software companies. The Rosen Forum is one of the most prestigious and important seminars in the industry. For further details on this 3-day session, contact Rosen Research Inc, 200 Park Ave, New York NY 10166, (212) 586-3530.

May 11-13

Custom Integrated Circuits Conference, CICC'81, Americana Hotel, Rochester NY. The CICC aims to bring together designers, producers, and users of custom integrated circuits to discuss recent developments and future directions in the field. Papers will be read on applications, algorithm-implementing integrated circuits, fabrication techniques, interfaces and interconnects, computer-aided design, and testing and qualification. Contact Dr Rajinder Khosla, General Chairman, Research Laboratories, B-81, Eastman Kodak Company, Rochester NY 14650, (716) 722-2525.

May 11-13

The Thirty-First Electronic Components Conference, Colony Square Hotel, Atlanta GA. Papers will be read on semiconductor-processing technology, optoelectronic devices, manufacturing technology, materials, hybrid

microcircuits, discrete components, interconnections, reliability, and connectors. Contact T G Grau, Bell Laboratories, Whippany Rd, Rm 3B-312, Whippany NJ 07981; or Electronics Industries Association, 2001 Eye St NW. Washington DC 20006.

May 14-16

The Tenth ASIS Mid-Year Meeting, Fort Lewis College, Durango CO. The American Society for Information Science's (ASIS's) theme for this year's meeting is "Using Information." Among the topics to be addressed are user studies, decision making, organizational change, government, education, management, access to information, and designing information systems for use. For information, contact ASIS, 1010 16th St NW, Washington DC 20036, (202) 659-3644.

May 17-20

Expo '81, Loew's Anatole Hotel, Dallas TX. Expo '81 is a combination of exhibits and technical sessions. The exhibits cover everything from graphics systems to industrial computer-control systems. The technical sessions range from tool design, design engineering, and robotics to numerical control. For more information, contact Numerical Control Society, 519 Zenith Dr, Glenview IL 60025, (312) 297-5010.

May 20-22

Joint Conference on Easier and More Productive Use of Computing Systems, University of Michigan, Ann Arbor MI. This conference intends to combine the insights of the social sciences, humanities, computer science, and human-factors engineering. Contact Gregory A Marks, 4258 Institute for Social Research, University of Michigan, Ann Arbor MI 48106, (313) 763-3482.

May 20-22

Videotex '81, Royal York Hotel, Toronto, Ontario, Canada. Videotext information systems allow users to call up information, make

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reservations, pay bills, exchange electronic mail, read an electronic newspaper, shop, and play video games. This conference will review videotext developments in Europe, Japan, and North and South America. Demonstrations of videotext systems will be given. Seminars on standards, legal aspects, and economic issues will be featured. Contact Videotex '81, 316 Lonsdale Rd, Suite 3, Toronto, Ontario, M4V 1X4, Canada, (416) 598-1981.

May 21-23

Annual Conference of the Educational Computing Organization of Ontario, Sheraton Centre and the Ontario Institute for Studies in Education, Toronto, Ontario, Canada. Exhibitions on the use of computers in schools and discussions on how to locate suitable educational materials will be featured. Contact the Conference Office, OISE, 252 Bloor St W, Toronto, Ontario, M5S 1V6, Canada.

June 1981

June 6-9

Atlanta Small Computer Show, Atlanta Hilton, Atlanta GA. Producers of small computers, peripherals, supplies, and services will be exhibiting at this show. Business owners, corporate and government executives, dataprocessing managers, doctors, lawyers, and other professionals are expected to attend. Obtain additional information from The Atlanta Small Computer Show, 4060 Janice Dr, Suite C-1, East Point GA 30344, (404) 767-9798.

Understanding and Using Computer Graphics, Chicago IL. This seminar covers the latest in graphic-system technology, including hardware, software, and applications. Contact Bob Sanzo, Frost & Sullivan Inc, 106 Fulton St, New York NY 10038, (212) 233-1080.

June 14-18

The Second National Conference of the National Computer Graphics Association, Baltimore Convention Center, Baltimore MD. Computer-graphics demonstrations, exhibits, and workshops will be held. Contact the National Computer Graphics Association Inc. 2033 M Street NW. Suite 330. Washington DC 20036, (202) 466-5895.

Iune 16-18

NEPCON East '81, New York Coliseum, New York NY. This exposition is aimed at engineers, prototype developers, production specialists and testing personnel. Technical programs will be presented. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

June 17-19

National Educational Computing Conference, North Texas State University, Denton TX. This conference will provide a forum for individuals and institutions interested in educational computing. Computer literacy, computer education for teachers, and computers in education are some of the topics to be covered. Contact Dr Jim Poirot, NECC-81 General Chairman, Computer Sciences Department, North Texas State University, Denton TX 76203.

June 20-22

The Fifth Annual Computerfest, Franklin University, Columbus OH. Talks on robots and calculators will be featured. Microcomputers and small-business systems will be presented. This show is being sponsored by the Midwest Affiliation of Computer Clubs and Franklin University. Contact Computerfest '81, Paul Pittenger, 215 Delhi Ave, Apt J, Columbus OH 43202, (614) 224-6237.

June 29-July 1

The Nineteenth Annual Meeting of the Association for Computational Linguistics, Stanford University, Stanford CA. Syntax, parsing, and sentence generation, computational semantics, discourse analysis and speech acts, speech analysis and synthesis, machine and machineaided translation, and mathematical foundations of computational linguistics are some of the topics to be discussed. Contact Don Walker, Artificial Intelligence Center, SRI International, Menlo Park CA 94025, (415) 326-6200, ext 3071.■

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Atari Inc has reduced the price of the Atari 400 computer with 8 K bytes of memory to \$530. The 16 K expanded version of the 400 is now selling for \$630. Atari also reduced the Model 810 51/4-inch floppy-disk drive to \$599.95.

On another front, Atari plans to begin selling a \$150 word-processing program later this year.■

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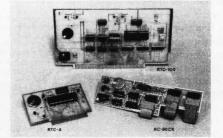
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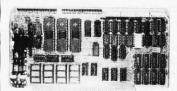
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PM-3	Personality module, programs TMS 2716	26.00
PM-4	Personality module, programs TMS 2532	34.00
PM-5	Personality module, programs 2716, TMS 2516	18.00
PM-6	Personality module, programs 2704	18.00
PM-7	Personality module, programs 2758, TMS 2508	18.00
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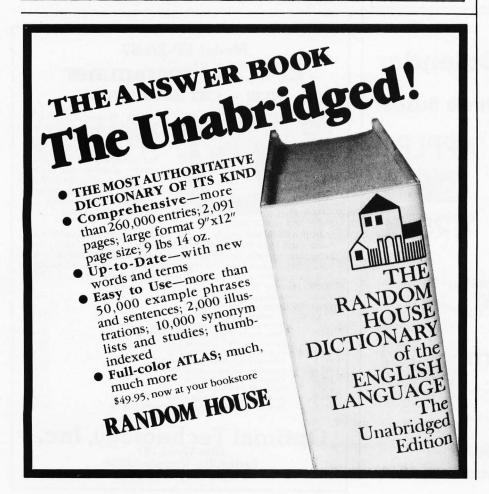
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Books Received

Advanced Micro Devices Condensed Catalog. Sunnyvale CA: Advanced Micro Devices Inc, 1981; 18 by 24.5 cm, 147 pages, softcover, no ISBN, free of charge.

COBOL, A Vehicle for Information Systems, Robert T Grauer. Englewood Cliffs NJ: Prentice-Hall Inc, 1981; 19 by 24.5 cm, 432 pages, hard-cover, ISBN 0-13-139709-5, \$18.95.

The Creative Kid's Guide to Home Computers, Fred D'Ignazio. Garden City NY: Doubleday & Company Inc, 1981; 16 by 24 cm, 130 pages, hardcover, ISBN 0-385-15313-9, \$9.95.

Digital Electronics Troubleshooting, Joseph J Carr. Blue Ridge Summit PA: Tab Books Inc, 1981; 13 by 21 cm, 350 pages, softcover, ISBN 0-8306-1250-5, \$9.95; hardcover, ISBN 0-8306-9677-6, \$16.95.

The Effective EDP Manager, Michael R Frank. New York: AMACOM, 1980; 16 by 23.5 cm, 197 pages, hard-cover, ISBN 0-8144-5635-9, \$17.95.

Experiments in Amplifiers, Filters, Oscillators, and Generators, Morris Tischler. New York: McGraw-Hill Book Company, Gregg Division, 1981; 22 by 28 cm, 170 pages, softcover, ISBN 0-07-064780-1, \$6.95.

Experiments in General and Biomedical Instrumentation, Morris Tischler. New York: McGraw-Hill Book Company, Gregg Division, 1981; 22 by 28 cm, 201 pages, softcover, ISBN 0-07-064781-X, \$8.95.

Experiments in Telecommunications, Morris Tischler. New York: McGraw-Hill Book Company, Gregg Division, 1981; 22 by 28 cm, 186 pages, softcover, ISBN 0-07-064782-8, \$7.95.

The FORTRAN Cookbook, Thomas P Dence. Blue Ridge Summit PA: Tab Books Inc, 1980; 13 by 21 cm, 334 pages, softcover, ISBN

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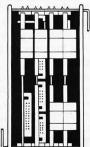
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Books Received.

0-8306-1187-8, \$8.95; hardcover, ISBN 0-8306-9914-7, \$14.95.

Guide to Microcomputers, Franz J Fredericks. Washington DC: Association for **Educational Communications** and Technology, 1980; 15.5 by 23 cm, 152 pages, softcover, ISBN 0-89240-038-2, \$11.50.

How to Build Your Own Working Microcomputer, Charles K Adams. Blue Ridge Summit PA: Tab Books Inc. 1980; 13 by 21 cm, 308 pages, softcover, ISBN 0-8306-1200-9, \$9.95; hardcover, ISBN 0-8306-9684-9, \$16.95.

Introduction to Computer Design and Implementation, S Imtiaz and Kwok T Fung. Rockville MD: Computer Science Press Inc, 1981; 16 by 23.5 cm, 271 pages, hardcover, ISBN 0-914894-11-0. \$19.95.

Introduction to Computers and Data Processing, Gary B Shelly and Thomas J Cashman. Fullerton CA: Anaheim Publishing, 1980; 21 by 27 cm, 498 pages, softcover, ISBN 0-88236-115-3, \$15.95. Accompanying the textbook are a Teacher's Guide and Answer Manual, Test Bank, and transparency masters. Student Workbook and Study Guide for above, 21 by 27 cm, 247 pages, softcover, ISBN 0-88236-116-3, \$5.95.

Introductory Structured COBOL Programming, Gary S Popkin. New York: Van Nostrand Reinhold Company, 1981; 19.5 by 24 cm, 471 pages, harcover, ISBN 0-442-26771-1, \$18.95.

The MC6809 Cookbook, Carl D Warren. Blue Ridge Summit PA: Tab Books Inc, 1981; 13 by 21 cm, 176 pages, softcover, ISBN 0-8306-1209-2, \$6.95; hardcover, ISBN 0-8306-9683-0, \$11.95.

Microprocessor Background for Management Personnel, James Arlin Cooper. Englewood Cliffs NJ: Prentice-Hall Inc, 1981; 16 by 23.5 cm, 163 pages, hardcover, ISBN 0-13-580829-4, \$14.95.

Microcomputer Interfacing Handbook: A/D & D/A. Joseph J Carr. Blue Ridge Summit PA: Tab Books Inc,



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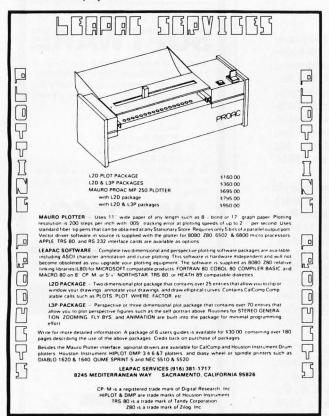
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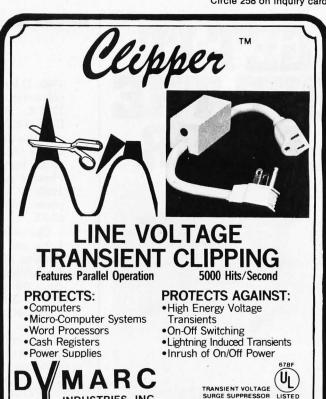
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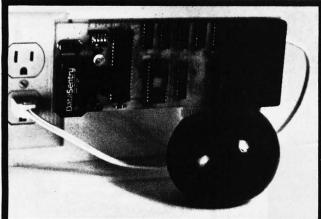
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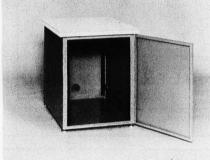
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Books Received.

1980; 13 by 21 cm, 350 pages, softcover, ISBN 0-8306-1271-8, \$8.95; hardcover, ISBN 0-8306-9704-7, \$14.95.

Motorola Optoelectronic Device Data, Motorola Technical Information Center. Phoenix AZ: Motorola Inc, 1980; 17.5 by 23.5 cm, 302 pages, softcover, no ISBN, \$3.25.

Operating Systems, Harold Lorin and Harvey M Deitel. Reading MA: Addison-Wesley Publishing, 1981; 17 by 24 cm, 378 pages, hardcover, ISBN 0-201-14464-6, \$19.95.

People and Project Management, Rob Thomsett. New York: Yourdon Press, 1980; 15 by 23 cm, 106 pages, softcover, ISBN 0-917072-21-9, \$10.50.

PET/CBM Personal Computer Guide, Second Edition, A Osborne and Carrol S Donahue. Berkeley CA: Osborne/McGraw-Hill, 1980; 16.5 by 23.5 cm, 501 pages, softcover, ISBN 0-931988-55-1, \$15.

The PLL Synthesizer Cookbook, Harold Kinley. Blue Ridge Summit PA: Tab Books Inc, 1980; 13 by 21 cm, 279 pages, softcover, ISBN 0-8306-1243-2, \$7.95; hardcover, ISBN 0-8306-9707-1, \$13.95.

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers' with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive: instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

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Software Received

This following is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Apple

ABM, graphics arcade game for the Apple II. Floppy disk, \$24.95. Muse, 330 N Charles St, Baltimore MD 21201.

Action Sounds and Hi-Res Scrolling, sound and graphics utility for the Apple II. Floppy disk, \$15.95. Avant-Garde Creations, POB 30161, Eugene OR 97403.

Animal Bingo, nonviolent strategy game for the Apple II. Floppy disk, \$9.95. Avant-Garde Creations (see above).

Apex Handy Disk #1, disk utilities for the Apex Operating System (on the Apple II). Floppy disk, \$39. Apparat Inc, 4401 S Tamarac Pky, Denver CO 80237.

Asteron, game for the Apple II. Floppy disk, \$27.50. Western Microdata Enterprises Ltd, POB 633, Postal Station G, Calgary, Alberta, T3A 2G1, Canada.

Courseware Magazine, education programs and documentation for the Apple II. Cassette, \$12.95 for a single issue or \$50 for 5 issues. Courseware Magazine, School of Business, California State University, Fresno CA 93740.

CRAE 2.0 (Co-Resident Apple Editor 2.0), Applesoft program editor for the Apple II. Floppy disk, \$24.95. Highlands Computer Services, 14422 S E 132nd St, Renton WA 98055.

The Creativity Life Dynamic Book, graphics-, music-, and poetry-generation game for the Apple II.

Floppy disk, \$19.95. Avant-Garde Creations (see above).

Jungle Safari, graphics game for the Apple II. Floppy disk, \$9.95. Avant-Garde Creations (see above).

Masterdisk, disk-examination utility for the Apple II. Floppy disk, \$29.95. Masterworks Software Inc, POB 7000-285, Rolling Hills Estates CA 90274.

MCAT 2.0, disk-catalog utility for the Apple II. Floppy disk, \$19.95. Highlands Computer Services (see above).

The Meaning Life Dynamic, graphics-game package for the Apple II. Floppy disk, \$15.95. Avant-Garde Creations (see above).

The Mine Fields of Normalcy, strategy game for the Apple II. Floppy disk, \$9.95. Avant-Garde Creations (see above).

Mystery Code, strategy game for the Apple II. Floppy disk, \$9.95. Avant-Garde Creations (see above).

Oldorf's Revenge, fantasy game for the Apple II. Floppy disk, \$19.95. Highlands Computer Services (see above).

Personal Property Inventory, cataloging utility for the Apple II. Floppy disk, \$14.95. Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662.

The Prisoner, strategy game for the Apple II. Floppy disk, \$29.95. Edu-Ware Services Inc, 22035 Burbank Blvd, Suite 223, Woodland Hills CA 91367.

Sentence Diagramming, teaching program for the Apple II. Floppy disk, \$19.95. Avant-Garde Creations (see above).

Star Avenger, graphics arcade game for the Apple II. Floppy disk, \$27.50. Western Microdata Enterprises Ltd (see above).

Tarturian, fantasy game for the Apple II. Floppy disk, \$24.95. Highlands Computer Services (see above).

VU #3, VisiCalc-based utility for the Apple II. Floppy disk, \$69.95. Progressive Software, POB 273, Plymouth Meeting PA 19462.

XPLO, programming language for the Apple II. Floppy disk, \$79. Apparat Inc (see above).

TRS-80

Attack Force w/Sound, graphics arcade game for the TRS-80. Cassette, \$14.95. Big Five Software, POB 9078-185, Van Nuys CA 91409.

Beef Cattle Least-Cost Ration Program, cost-analysis program for the TRS-80. Cassette, \$5. Agricultural Software Consultants Inc, 1706 Santa Fe, Kingsville TX 78363.

Blackjack Master, blackjack strategy game for the TRS-80. Floppy disk, \$24.95. Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662.

Galaxy Invasion, graphics arcade game for the TRS-80. Cassette, \$14.95. Big Five Software (see above).

Personal Property Inventory, cataloging utility for the TRS-80. Floppy disk, \$14.95. Hayden Book Company Inc (see above).

Starclash, strategy game for the TRS-80. Floppy disk, \$16.95. Hayden Book Company Inc (see above).

CP/M

Communications Software Package, utility for CP/M systems. Floppy disk, \$60. Datastat Systems Inc, 631 B St, San Diego CA 92101.

Datastar, key-to-disk dataentry program for the CP/M operating system. Floppy disk, \$350. MicroPro International Corporation, 1299 Fourth St, San Rafael CA 94901.

Pascal/M, programming language for the CP/M system. Eight-inch floppy disk, \$175. Sorcim, POB 32505, San Jose CA 95152.

Supersort I, record-sorting utility for the CP/M operating system. Floppy disk, \$250. MicroPro International Corporation (see above).

WordMaster, video-based text editor for the CP/M operating system. Floppy disk, \$150. MicroPro International Corporation (see above).

WordStar, word-processing program for the CP/M operating system. Floppy disk, \$495. MicroPro International Corporation (see above).

Other Computers

Budget Manager, personalutility program for the APF Imagination Machine. Cassette, \$19.95. APF Electronics, 1501 Broadway, New York NY 10036.

Full Screen Editor, textmanipulation program for the Heath H-89. Floppy disk, \$24.95. Heath Company, Benton Harbor MI 49022.

Jinsam 8.0, data-base-management program for the Commodore CBM 8032. Floppy disk, \$175. Jini Micro-Systems Inc, POB 274, Kingsbridge Sta, Bronx NY 10463.

Personal Business Machine, personal-utility program for the APF Imagination Machine. Cassette, \$29.95. APF Electronics (see above).

Ramscan, memory diagnostic test for the Atari 800. Floppy disk, \$15. Axlon Inc, 170 N Wolfe Rd, Sunnyvale CA 94086.

Space, Size, and Surface Guide, personal-utility program for the APF Imagination Machine. Cassette, \$29.95. APF Electronics (see above).

BYTE's Bits

Results of "What Is It?" Contest

In the April 1980 BYTE, we announced a contest. In the "What's New?" section, on page 247, we printed a picture of an anonymous mechanical device and challenged readers to identify it. The first person to respond with the correct answer was to receive the device as a prize.

Tony Caloggero of Nahant, Massachusetts, won the contest. It is called Stepdozer, a product of the Gakken Company of Japan. The Stepdozer is part of a line of mechanical toys known as Space Mechanimals.

Other readers sent in varying descriptions of the beasty. Several readers stated that it was part of a cash register. One reader gave a specific description as a 1903 C L Smith adding machine, with

the battery pack thrown in as a "red herring." Another reader guessed several possibilities: "a doughnut dunker, an automatic pitchfork, or a piece of my spaceship." Yet another suggested that it was a model of an oil pump. These descriptions were slightly off the mark.

Several readers came closer, by describing it generically as "a walking machine." One reader said that he recognized it instantly as a "Rien de Toot," and we received one letter identifying the device as a "mechanical Trojan horse."

Finally, we would like to quote extensively from a reader in University, Alabama, who wrote:

Good heavens, economist worth his salt knows the answer-it's a portable widget, with a selfcontained power source. It's

used as a product example in almost every freshman economics course in the country. Get with it-you folks are slipping! Next time, show us something really hard to guess, like an inversely truncated framistan!

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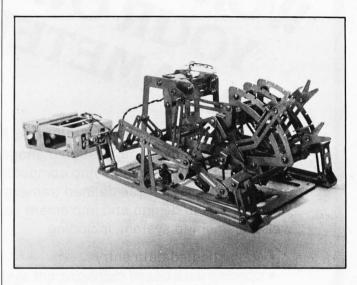


Photo 1: A Stepdozer for Tony Caloggero. He guessed it, he got it.

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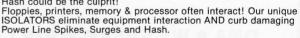
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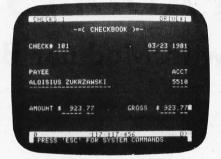
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PADDLES

Interfacing with Modular Breadboards

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Often, microcomputer interfacing is a simple task requiring only a basic knowledge of digital electronics. The availability of breadboarding sockets has made building and testing of digital electronics circuits relatively easy. (Breadboard sockets considered here are the E & L Instruments SK-10 and the AP Products Super Strip.) The ease of digital-circuit testing with breadboards can be extended to microcomputer interfacing by use of functional modules which plug into these breadboards. We call these modules PADDLEs (Peripheral Analog/Digital Device-Logic Extensions).

Breadboarding sockets have made building and testing digital electronics relatively simple.

The various PADDLE modules perform the following functions: address decoding for device selection, D/A (digital-to-analog) conversion, A/D (analog-to-digital) conversion, displaying data, and debouncing switches. Once you have built these circuits in modular form, you will not have to build them from scratch for every breadboard project, and you will not have to use valuable breadboard space that could otherwise be delegated to the project at hand.

It is best to avoid constructing modules so complex that their use becomes cumbersome and their utility limited. For this reason, we shall consider building PADDLEs to perform only those functions which are often called for in digital circuits and which are easily integrated into prototype interface circuitry.

We have found a minimum configuration of five PADDLEs most useful both for interfacing projects and for instruction. These consist of (1) a set of three switch-debouncing circuits, (2) a set of eight logic switches having a latched-pulse output for interrupt generation, (3) a dual seven-segment display, (4) an A/D-D/A converter and comparator for either analog-to-digital or digital-to-analog conversion, and (5) a device decoder capable of generating eight unique outputs from an 8-bit input.

A single 8-bit address decoder PADDLE can be used to select devices, provided the microcomputer uses accumulator I/O (input/output). In order to decode a 16-bit memory address, two decoder PADDLEs would be necessary. Though the PADDLEs can be used with other microprocessors, our focus is on the 8080 family. In the following text we consider each of these PADDLEs in terms of function and design.

Pulser PADDLE

This PADDLE (see figure 1) generates a digital pulse, either positive or negative, that is devoid of the bouncing (momentary intermittent contact) always found in mechanical switches. This is done by the use of an RS (set-reset) flip-flop. Often an RS flip-flop is constructed from two NAND gates; however, the same result can be obtained by the use of two inverters. Either a positive or negative pulse is available at the output of each RS flip-flop. With a single type-7404 hex inverter, three RS flip-flops can be constructed (rather than two using a single 7400 quad NAND gate).

The operation of an RS flip-flop constructed from either inverters or NAND gates is controlled by the current-sinking ability of a TTL (transistor-transistor logic) device output, since a floating input connected to an output that is low will also be pulled low. These pulsers are a means of manually generating signals that can be used to enable or clear such devices as monostable multivibrators (one-shots), counters, latches, and so on.

Logic Switch PADDLE

As the name implies, the device in figure 2 allows definition of a logic 1 or 0 on each of eight parallel lines. A single-pulse switch is also provided to generate an interrupt pulse that is latched by a 7474 D-type latch. Each of the eight lines is three-state buffered and enabled by the same external pulse that clears the D latch. Used with an 8080A microprocessor, the output line marked P can be tied to INT (the processor's interrupt line) and the input-enable signal, labeled E, can be connected to the microprocessor's interrupt-acknowledge line, INTA. This allows the PADDLE to function as an interrupting device. Once INT has been accepted, INTA will gate the instruction defined by the logic switches (usually a special-restart subroutine call, RST X) onto the data bus.

Number	Type	+5 V	GND
IC1	Type 7404	14	7

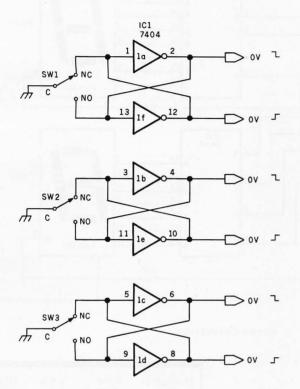
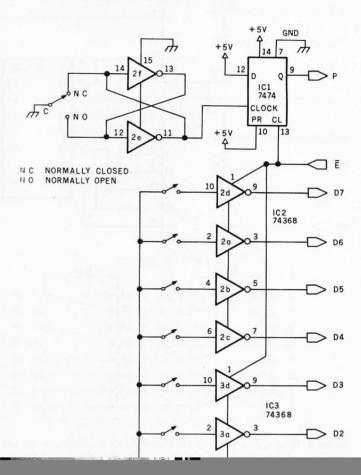


Figure 1: Schematic of a PADDLE for manually producing bounceless pulses. SW1 thru SW3 are momentary-contact switches; A thru F are sections of a 7404 hex inverter integrated circuit.

Number	Type	+ 5 V	GND
IC1	7474	14	7
IC2	74368	16	8
IC3	74368	16	8



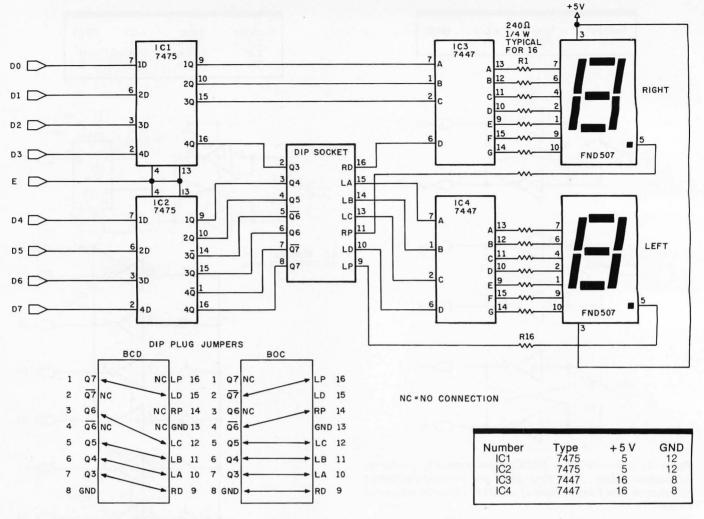


Figure 3: Binary data on lines D0 thru D7 can be displayed on two seven-segment LED (light-emitting diode) displays in either BCD (binary-coded-decimal) or BOC (binary/octal-code) format (see text) using the Display PADDLE. Resistors R1 thru R16 are 240-ohm ¹/₄ W.

Binary/octal-code format is binary in the sense that the two most significant bits are displayed on the decimal points, and it is octal since the remaining six bits are displayed as two octal digits on the seven-segment displays. BOC represents a substantial advantage over normal numeric display because only two rather than three displays and decoders are required. Although one could monitor the eight lines using alphanumeric hexadecimal displays, these are much more expensive than seven-segment displays with decimal points.

The ability to use the displays in either a BCD or BOC format is selected by using one of two jumper-wired dual-inline plugs inserted into a 14-pin DIP (dual-inline package) socket. The eight data-input lines, D0 thru D7, are brought to a pair of 7475 quad D latches. The outputs of the latches, Q0 thru Q7, Q6, and Q7, are routed via the DIP plug to obtain the selected display format. In either configuration, signals from Q0 thru Q2 bypass the DIP plug and connect directly to the three least significant inputs of the 7447 decoder-driver for the right-hand display.

In the BCD configuration, the DIP plug directs Q3 to the MSB (most significant bit) input of IC3, the righthand 7447, and Q4 thru Q7 to the appropriate inputs of IC4, the left-hand 7447. The decimal points of the displays are not connected.

In the BOC configuration, the DIP plug directs Q3 thru Q5 to IC4, grounds the MSB inputs of both 7447s, and connects Q7 and Q6 directly to the left- and right-hand decimal points of the FND 507 LED displays. Use of the logical complements of Q6 and Q7 is necessary because the FND 507 is a common-anode display.

On the PADDLE module, the gating inputs to the 7475 quad D latches are tied together and labeled E (enable). When E is at logic 1, the data present on lines D0 thru D7 is displayed; on the 1-to-0 transition it is latched. In this manner the Display PADDLE can be used as an output device (provided proper address decoding is implemented to allow the 7475s to latch the data bus at the correct time).

A/D-D/A PADDLE

The PADDLE in figure 4 can be used as either an A/D (analog-to-digital) converter or a D/A (digital-to-analog) converter. It consists of the following: a 7404 hex inverter, two 7475 quad D latches, a 1408L8 8-bit D/A converter, a 741 operational amplifier (op amp), and a 311 voltage comparator. Because the latter three devices re-

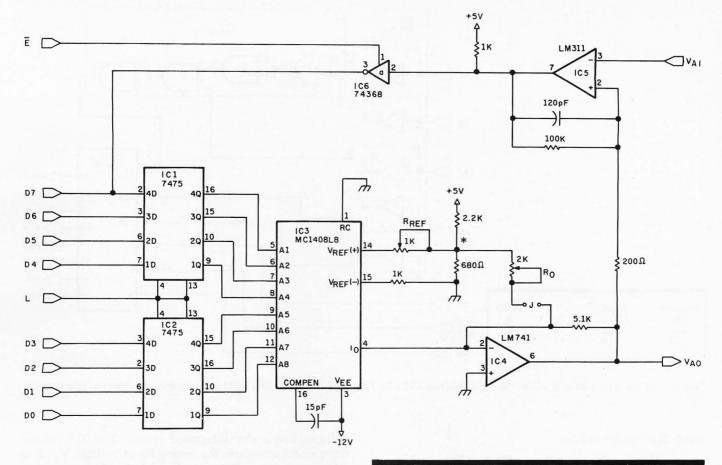


Figure 4: Analog-to-digital and digital-to-analog conversion of data is performed by the A/D-D/A PADDLE in conjunction with the SAP program in listing 2. V_{AI} and V_{A0} are the analog input and output lines, respectively. The asterisk indicates the voltage reference point; jumper J allows generation of negative output voltages. IC 6 is one section of a 74368 integrated circuit.

Number	Type	+5 V	GND	- 12 V	+ 12 V
IC1	7475	5	12		
IC2	7475	5	12		
IC3	MC1408L8	13	2		
IC4	LM741			4	7
IC5	LM311		1	4	8
IC6	74368	16	8		

quire +12 V and -12 V, wire-insertion sockets labeled + V and - V are provided on the PADDLE for connection to an external power supply.

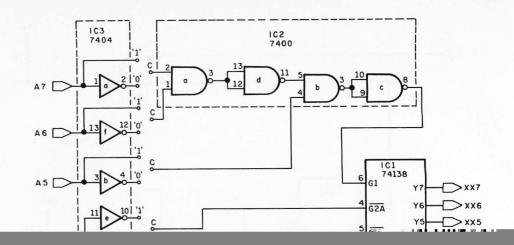
Let us first consider the use of this PADDLE as a D/A converter and note its limitations. The PADDLE is designed so that once an 8-bit word is latched by the 7475s, the 1408 D/A converter converts this byte into a proportional current. The 741 operational amplifier connected to the output of the D/A converter serves as a current-to-voltage converter. When the jumper shown in figure 4 is *not* inserted, the D/A converter is in a unipolar mode and can generate voltages between 0 and the positive external power-supply voltage. In the unipolar mode, the voltage range is dependent upon the reference current supplied to the D/A converter and the amplifier feedback resistance at the output of the D/A converter. The calculation of this voltage is based on the digital value of the 8 bits D0 thru D7:

$$V_{AO} = \frac{V_{ref}}{R_{ref}} R_f \left(\frac{D0}{2} + \frac{D1}{4} + \frac{D2}{8} + \frac{D3}{16} + \frac{D4}{32} + \frac{D5}{64} + \frac{D6}{128} + \frac{D7}{256} \right)$$

where $R_{\rm ref}$ is the resistance provided by a 1 k-ohm potentiometer and $R_{\rm f}$ is 5.1 K-ohms (from the amplifier feedback resistor). Note that $V_{\rm ref}$ at the node labeled with the asterisk in figure 4 is determined by the voltage-divider circuit and is calculated to be 1.18 V. As $R_{\rm ref}$ is reduced to zero, the voltage output goes to a minimum value of approximately +4.0 V. Based on the previous equation, we can infer that an impedance of about 500 ohms exists at pin 14 of the 1408L8.

To use the D/A converter in a bipolar mode requires insertion of a jumper on the PADDLE. This jumper connection is made between two wire-insertion sockets. It introduces an offset current via R_0 that permits negative output voltages to be obtained. Note that $R_{\rm ref}$ as defined can be interpreted as a *scaling* factor because it approximately defines the range of voltage values possible at the output V_{AO} .

This only approximately defines the range in the bipolar mode because of the parallel resistance of $R_{\rm 0}$ introduced into the voltage-divider circuit. Because the inverting input of the operational amplifier is at virtual ground, the resistance from $V_{\rm ref}$ to ground now becomes the 2.2 k-ohms of potentiometer $R_{\rm 0}$ in parallel with the 680-ohm resistor. Introducing the offset current $(V_{\rm ref}/R_{\rm 0})$



8-Bit Device Decoder PADDLE

This PADDLE uses one 7404 hex inverter, one 7400 quad NAND gate, and a 74138 3-to-8-line decoder (see figure 5). It allows generation of device-select pulses for use in accumulator I/O typical of the 8080 family of microprocessors. As a decoder, the PADDLE provides unique decoding for eight adjacent device codes from XX0 to XX7 over the range of 256 devices. This is done by

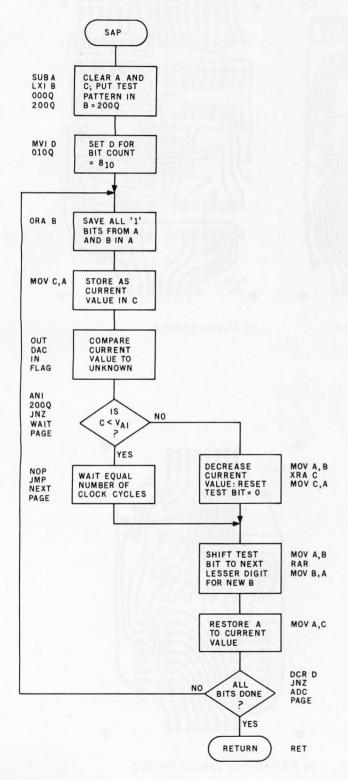


Figure 6: A flowchart of SAP, the successive-approximation program of listing 2. The 8080 code is shown with each flowchart step.

jumpers in wire-insertion sockets on the PADDLE, which select unique decoding for A7 thru A3 (or A15 thru A11) of the address bus lines.

Once a device code is generated, it <u>must be ORed</u> (off of the PADDLE module) with either $\overline{I/OR}$ (referred to as \overline{IN}) or $\overline{I/OW}$ (\overline{OUT}) to create a device-select pulse for input or output, respectively. \overline{IN} and \overline{OUT} are obtained by NANDing the appropriate latched status bit with the control pulses DBIN (input) or \overline{WR} (output) on an 8080 processor. In terms of the S-100 bus, \overline{IN} is defined as \overline{SINP} (pin 46) NANDed with pDBIN (pin 78), while \overline{OUT} is \overline{PWR} (pin 77) inverted and NANDed with sOUT (pin 45).

Construction Details

The printed-circuit layouts for the five PADDLEs are presented in figure 7. Each board is 3 inches long and either 1½ or 2 inches wide. The extra section of the Display PADDLE which supports the seven-segment display at a comfortable viewing angle is 1½ inches long.

The component layouts for the PADDLEs are given in figure 8. Because the layouts are for single-sided copper foil, all jumpers, as well as all other components, were run parallel to the edges of the PADDLE, with none of the jumper wires crossing. Note that the pins for power and ground must be carefully aligned for insertion into the breadboard. The power bus is assumed to be the outer strip on the breadboard.

All circuit-board holes were drilled with a #65 drill bit (with the exception of holes for wire-insertion sockets; these required a #55 drill bit). The small switches used for the pulsers required that slots be cut with the wheel-cutter blade of a Dremel tool. Marks are provided on the switch pads for guide holes to be drilled at each end of the slots.

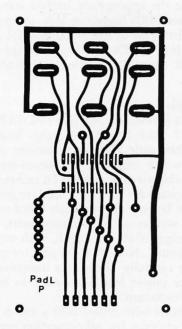
It was found convenient to mount the Display, 8-Bit Address Decoder, and A/D-D/A PADDLEs on the side of the breadboard away from the experimenter, while the Logic Switch and Pulser PADDLEs were plugged into the breadboard on the side nearest the experimenter (see photo 1). This accounts for the manner in which the PADDLEs were labeled in figure 7.

With this arrangement, switches and pulsers are close at hand and easy to manipulate, while the display is positioned to face the experimenter and the wire-insertion sockets and their associated jumpers are out of the way.

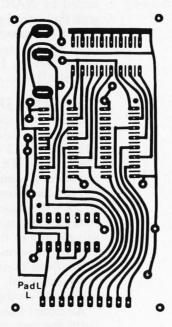
Once the circuit boards are etched, drilled, and tinplated, the following steps provide the most systematic approach for assembly:

- 1. Spray-paint the component side of the board with enamel.
- 2. Label component side with transfer letters.
- 3. Spray labels with clear acrylic coating.
- 4. Insert wire jumpers; solder and trim leads.
- 5. Insert resistors; solder and trim leads.
- 6. Insert and solder IC sockets.
- 7. Insert and solder potentiometers.
- 8. Insert capacitors; solder and trim leads.
- 9. Using either wire-wrap posts or #24 gauge wire, mount breadboard-insertion pins so that they extend 0.3 inches below the board, solder, and trim flush on component side.
- 10. Insert and solder wire-insertion sockets.

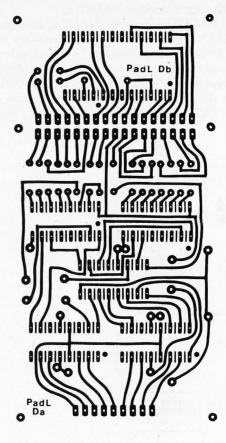
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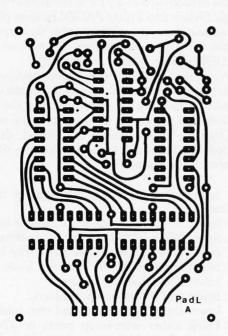


(b) Logic Switch PADDLE

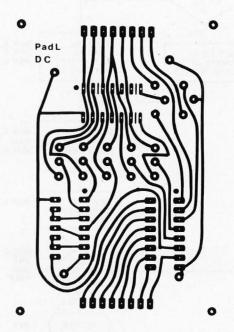


(c) Display PADDLE

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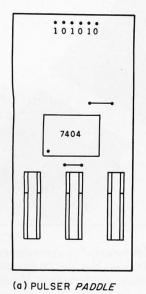


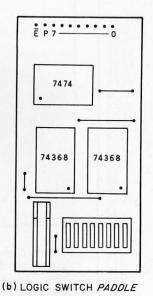
(d) A/D-D/A PADDLE

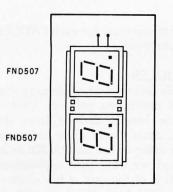


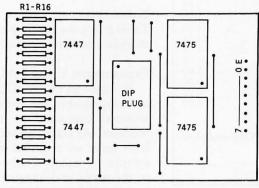
(e) 8-Bit Address Decoder PADDLE

Figure 7: Full-size printed-circuit-board patterns for the five PADDLEs.

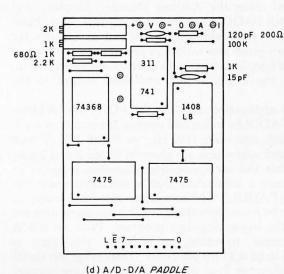


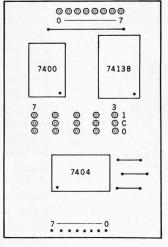






(c) DISPLAY PADDLE





(e) ADDRESS-DECODER PADDLE

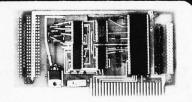
Figure 8: Component view of the individual PADDLEs.



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Logic Swite 1 2 1 2 2 2 2 2 2 5 1 16	DDLE: Total 7404 14-pin IC socket Cherry Microswitch ch PADDLE: Total 7474 74368 14-pin IC socket 16-pin IC socket MDDLE: Total 7447 7475 FND 507 DIP plugs (16 pin) 16-pin IC sockets 24-pin IC socket 240-ohm, ¼ W resistors ADDLE: Total 7475 7475 74368	\$5.93 0.18 0.20 1.85 \$2.37 0.35 0.69 0.20 0.22 \$7.87 0.59 0.49 0.99 0.70 0.22 0.38 0.05 \$14.10 0.49
1 1 1 5 6	LM311 741 MC1408L8 16-pin IC sockets wire insertion sockets	0.90 0.35 5.75 0.22 0.23
Resistors: 1 1 1 1 1 1 1 Device Co 1 1 1 2 1 24	680 ohm, ¼ W 1 K, ¼ W 2.2 k-ohm, ¼ W 5.1 k-ohm, ¼ W 100 k-ohm, ¼ W 1 k-ohm potentiometer 2 k-ohm potentiometer de PADDLE: Total 7400 7404 74138 14-pin IC sockets 16-pin IC socket wire insertion sockets	0.05 0.05 0.05 0.05 0.05 1.35 1.35 \$7.17 0.16 0.18 0.69 0.20 0.22

Table 2: Components necessary for each PADDLE and their approximate costs.

Listing 3: Program to log 256 points of an analog signal by calling SAP and then display the resultant conversions, used in conjunction with the PADDLE setup in figure 10.

	LXI H TABLE PAGE	/INITIAL ADDRESS OF DATA TABLE
LAD,	CALL SAP PAGE	/CONVERSION SUBROUTINE /RETURN WITH VALUE IN C
	MOV M,C INR L INZ LAD	/PUT POINT IN TABLE /NEXT TABLE POSITION /LOGGED 256 POINTS? /NO
DISC,	PAGE MOV A,M MVI D 1DH	/YES:GET POINT FROM TABLE /SET DELAY FOR DISPLAY
STALL,	OUT DAC	/DISPLAY POINT
	DCR D JNZ STALL PAGE	/COUNTDOWN /DELAY DONE? /NO
	INR L JMP DISC PAGE	/NEXT TABLE POSITION /ENDLESS DISPLAY

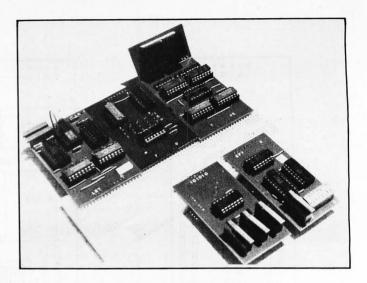


Photo 1: Complete PADDLEs mounted on a breadboard socket. Starting at bottom center and moving counter-clockwise: Pulser, Logic Switch, Display, 8-Bit Address Decoder, and A/D-D/A.

Text continued from page 353:

Table 2 lists the components necessary for each PADDLE module and their approximate costs.

Experiments Using PADDLES

This guintet of PADDLEs defines a set of circuitry that is indispensable for most interfacing projects. Cost is minimal compared to the benefit derived from the modules. As stated above, usually only a few additional logic gates are required in order to use the PADDLEs as peripheral devices. Although we leave their applications to the needs and imagination of the user, a few elementary applications are described here. We have already discussed how to implement the Logic Switch PADDLE as a vectored-interrupt device to enter an RST instruction.

A second application for a simple I/O circuit can be constructed using the Address Decoder, Display, and Logic Switch PADDLEs as shown in figure 9. This circuit requires only four additional gates and an inverter for device-select-pulse generation. A program to test the circuit would contain a loop with instructions to receive input from the Logic Switch and send output to the Display.

A third application uses the A/D-D/A and Address Decoder PADDLEs to log and display 256 points of a 4 V peak-to-peak sine wave (100 Hz, see figure 10). A main program and subroutine are given in listing 2 and listing 3. Note that the successive-approximation program of listing 2 uses a subroutine that is discussed under the A/D-D/A PADDLE. The conversion rate from analog to digital can be found by calculating the execution time per point of the log-analog-data program. With an 8080A microprocessor operating at 2 MHz, this time is calculated to be 0.41 ms per point. (Displaying this signal on an oscilloscope in an undistorted digital form requires the same rate of display as conversion; this is done by use of the D register as a delay counter in the displayconversion program.)

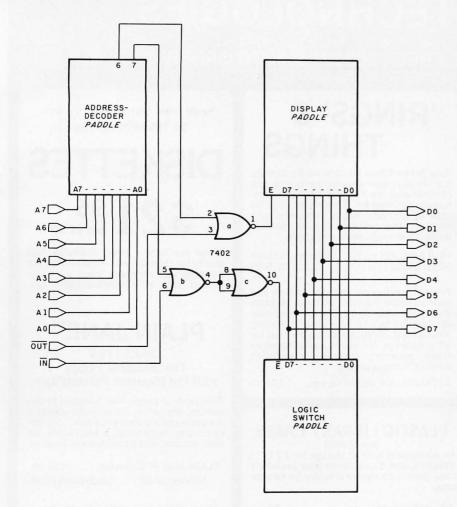


Figure 9: Configuring three PADDLEs as an I/O (input/output) device for an 8080-type system requires a single 7402 inverter.

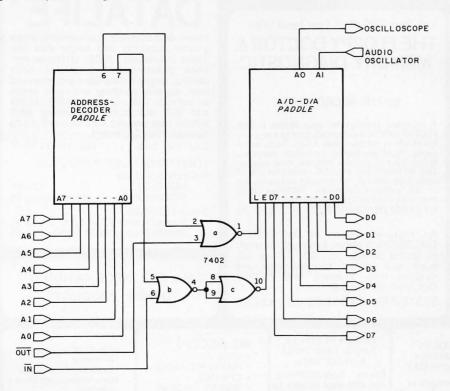
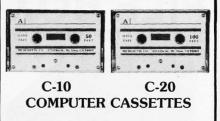


Figure 10: PADDLE configuration to convert the output of an audio oscillator to digital form and back to analog for display on an oscilloscope.

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Help prevent data loss and media damage due to improper diskette centering and rotation with the FLOPPY SAVERTM reinforcing hub ring kit. 7-mil mylar rings install in seconds. Kit is complete with centering tool, pressure ring, 25 adhesive backed hub rings and instructions.

HUB RING KIT for 51/4" diskettes . \$10.95 REFILLS (50 Hub Rings) \$ 5.95

Protect your expensive disk drives and your valuable diskettes with our diskette drive head cleaning kit. The kit, consisting of a pair of special "diskettes", cleaning solution and instructions, can be used for 52 cleanings. Removes contamination from recording surfaces in seconds without harming drives.

CLEANING KIT for 51/4" drives ... \$24.95

PLASTIC LIBRARY CASES

(not shown)

An economical form of storage for 10 to 15 diskettes, and is suitable for your bookshelf! Case opens into a vertical holder for easy ac-

51/4-inch diskette case \$3.50 8-inch diskette case \$3.95

Let Your TRS-80™ Test Itself With

THE FLOPPY DOCTOR &

MEMORY DIAGNOSTIC

by THE MICRO CLINIC

A complete checkup for your Model I. THE FLOPPY DOCTOR completely checks every sector of 35- or 40-track disk drives. Tests motor

speed, head positioning, controller functions,

status bits and provides complete error logging.
THE MEMORY DIAGNOSTIC checks for proper

write/read, refresh, executability and exclusivity of all address locations. Includes both diagnostics and complete instruction manual.

SYSTEM DIAGNOSTICS.....\$19.95

Single Sided, Soft-Sectored 51/4-inch, (for TRS-80TM) Mini-floppy

DISKETTES

These are factory fresh, absolutely first quality (no seconds!) mini-floppies. They are complete with envelopes, labels and writeprotect tabs in a shrink-wrapped box.

PLAIN JANE™

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Thousands of people have switched to this low-cost alternative. These quality diskettes are packaged in a plain white box . . . no fancy printing, fancy names or fancy labels, not even our own (labels cost money). Trust us.

PLAIN JANETM Diskettes \$21.95 10 boxes of 10 . . . (each box)\$21.50

VERBATIM'S PREMIUM DISKETTES AT AFFORDABLE PRICES

Seven data-shielding improvements mean greater durability and longer data life.
These individually, 100% error-free certified diskettes feature thicker oxide coating, longer-lasting lubricant, improved liner, superior polishing and more! Meets or exceeds IBM, Shugart, ANSI, ECMA and ISO standards. Reinforcing HUB RINGS help prevent data loss and media damage, reducing errors.

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VERBATIM DATALIFETM DISKETTES

51/4-inch (box of 10) MD525-01 10 boxes of 10 (each box)\$25.95

8-inch FLOPPIES

Single-Density, FD34-1000 . . \$33.95 Double-Density, FD34-8000 . \$43.95

CALL FOR INFORMATION ON OTHER PRODUCTS

MICROPARAPHERNALIA DISKETTES (box of ten)

	7
51/4" PLAIN JANETM \$	21.95
51/4" DATALIFETM MD 525-01\$	26.95
8" DATALIFETM FD34-1000 \$	33.95
8" DATALIFETM FD34-8000 \$	43.95

NEWDOS by APPARAT

NEWDOS/80 ★ SPECIAL \$129.95 NEWDOS + to NEWDOS/80 UPGRADE CALL NEWDOS + with ALL UTILITIES

35-track\$69.95 40-track \$79.95

BOOKS

TRS-80TM DISK

AND OTHER MYSTERIES . . \$19.95 MICROSOFT™ BASIC DECODED \$29.95 1001 THINGS TO DO WITH YOUR

PERSONAL COMPUTER \$ 7.95

An improved version of the SYSTEM DIAGNOSTICS above. Designed for single or double density, 35-, 40-, 77-, or 80-

track disk drives. Includes new and modified tests. Features THE FLOPPY DOCTOR, Version 3.0.

SYSTEM DIAGNOSTICS-V3.. \$24.95

TRS-80 is a trademark of the Radio Shack Division of Tandy Corporation. DATALIFE is a trademark of VERBATIM. PLAIN JANE, AIDS-I, AIDS-III, CALCS-IVI, CALCS-IV, MERGE-III are trademarks of MTC.

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What's New?

PUBLICATIONS

UPTREND

UPTREND is written and designed to help owners of Personal Software's programs increase their productivity. It includes how-to articles on program usage, questions and answers, information on the programs themselves, and letters and interviews with program users. The publication is sent to owners of Personal Software's programs, and it is available at computer retail stores selling the company's products. Contact Personal Software Inc, 1330 Bordeaux Dr, Sunnyvale CA 94086, [408] 745-7841.

Circle 400 on inquiry card

1980 APL Users Meeting Proceedings

The proceedings of the October 1980 APL users meeting are available from I P Sharp Associates. The book is comprised of 52 papers read at the meeting. The subjects covered are APL resources, APL for financial applications and economic forecasting, international networks, personneland record-handling systems, inhouse APL timesharing services, APL techniques and programming tools, teaching APL, and more. The price is \$18 per copy. Contact I P Sharp Associates Ltd, Publications Department, 145 King St W, Toronto, M5H 1J8, Canada, (416) 364-5361. In the US, address I P Sharp Associates Inc, 1200 First Federal Plz, Rochester NY 14614, (716) 546-7270.

Circle 401 on inquiry card

Music and Microprocessors

Hal Chamberlin's Musical Applications of Microprocessors provides coverage of digital microprocessorsound and music synthesis. This book discusses linear techniques for microprocessor applications, musical applications for 16-bit microprocessors, and all phases of waveform shaping and filtering. Waveform charts, nomographs, and sample control and generation programs written in BASIC are provided to inspire experimentation and application. It is published by Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662, (201) 843-0550. The cost is \$24.95.

Circle 402 on inquiry card

H H Smith Catalog



H H Smith Inc, a manufacturer of electronic components and hardware, has published Catalog 810 for design engineers and purchasing agents. Printed-circuit board supports, cable clamps, and spacers are among the items featured. Contact H H Smith Inc, 812 Snediker Ave, Brooklyn NY 11207, (212) 272-9400.

Circle 403 on inquiry card

Micro Media Magazine

This bimonthly magazine provides software reviews, graphic art, advertisements, articles, and more for the Heath H-8, -88, -89, and Zenith Z89 computers. The magazine comes in an interesting format: on a floppy disk.

Subscriptions are \$11.95 for a single issue and \$55 for a year. Micro Media supports its subscribers by making the magazine available in both Benton Harbor and Microsoft BASIC, as well as HDOS or CP/M disk formats. Contact Micro Media at POB 402286, Garland TX 75040, (800) 527-4830, ext 101; in Texas (800) 442-4884, ext 101.

Circle 404 on inquiry card

TRS-80 Users Software News

CIE People's Software News is free to TRS-80 users. The publication has news of the activities at People's Software, where public-domain software is distributed for a copying charge. The price for a cassette of programs is \$10.95. The current 5-tape library contains 206 programs, for \$54.75. Contact the Computer Information Exchange Inc, POB 159, San Luis Rey CA 92068, [714] 757-4849. Circle 405 on inquiry card

H-8 Programming for Beginners

This book, written by Don Inman, Ron Santore, and Bob Albrecht, is designed for Heathkit H-8 users. Computer terms are defined for beginners, and each chapter tests the reader's knowledge by challenging him or her to write a short program or subroutine. The book is a short programming course that explains assembly language and serves as an introduction to Benton-Harbor BASIC. It is available for \$8.95 from the Dilithium Press, 30 N W 23rd Pl, Portland OR 97210, (503) 243-1160.

Circle 406 on inquiry card

Software Buyer's Guide

The Official Software Buyer's Guide is published each January and July. It contains listings of software for business applications, word processing, operating systems, games, and general programs for many microcomputers. For information on space deadlines, advertising rates, and availability, contact OSBG, Listing Department, POB 18278, Reno NV 89511, (702) 356-8400.

Circle 407 on inquiry card

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

SYSTEMS

Small Business System from Systel



The REPORT/80 is a portable business system for less than \$10,000. It combines the 8085 and Z80 microprocessors, 64 K bytes of memory, a keyboard; a 12-inch, 80-column by 25-line video display, two 5-inch floppy-disk drives, a 9 by 7 dot-matrix printer, and two RS-232C serial ports in a single unit. CP/M is included. Systel offers a selection of business programs as an option. The Model 11 has a suggested retail price of \$8950, and includes two double-sided, double-density drives. The Model 15 has two double-sided, quad-density drives, and costs \$9950. For more information, contact Systel Computers Inc, 20370 Town Center Ln, Cupertino CA 95014, (408) 253-0992.

Systems from Zeda

Circle 408 on inquiry card

The 520 series of portable microcomputers feature a Z80A microprocessor, a video display, floppy-disk drive, and detachable keyboard. The series can be powered by standard 110 VAC current, 12 VDC, or optional internal batteries. You can order your system with either a 5-, 9-, or 12-inch video screen (ie: the Models 525, 529, or 522, respectively). The series has 48 K bytes of programmable memory, 2 K bytes of video programmable memory, a double-density floppy-disk-drive controller, and a 200 K-byte drive. A 400 K-byte quad-density drive is available. Up to three drives can be added to the system. A Centronics printer port, an RS-232C serial port, and a bar-code-reader port for a Hewlett-Packard HEDS-3000 digital wand are provided. The CP/M-compatible



ZEDOS operating system has all the CP/M and CDOS + system calls, plus ZEDOS calls. A status line displays a program counter; disk-error information; a low-power indicator; a typeahead buffer; system idle, screen frozen, and printer activated flags; and disk status. The prices are \$4495 for the 522, \$3995 for the 525, and \$4195 for the 529. Contact Zeda Computers International Ltd, 1662 W 820 North, Provo UT 84601, (801) 377-9948.

Circle 410 on inquiry card

6800/6809 Development Systems Can Offer 2-Megabyte Storage

The Scoutsystem development systems from SSB (Smoke Signal Broadcasting) are for 6800/6809 microprocessors. They provide 2 megabytes of floppy-disk storage and up to 64 K bytes of programmable memory. The series features a video display, dual 5- or 8-inch disk drives, plus SSB's Hunter debugging package, which allows memory, register, and stack contents to be inspected and changed. Software includes a macroassembler that provides relocatable code. An MDOS conversion package permits files generated under it to be read by SSB's DOS68 or DOS69 and vice versa. A text editor and text processor are available. The EPROM (erasable programmable read-only memory) programmer can handle 1 K-, 2 K-, or 4 K-byte EPROM s. An optional in-circuit emulator allows the host system to be tied into the target system. The Scoutsystem series also contains a diagnostic routine for identifying failed integrated circuits. Prices for the Scoutsystem series range from under \$5700 to \$7745. Contact Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village CA 91362, (213) 889-9340.

Circle 409 on inquiry card

6809 Board for the Apple II

The Mill is a 6809 microprocessor board that plugs into the Apple II. It can be used in manufacturing or laboratory process-control monitoring and concurrent programming tasks. Users can run existing 6502 programs, 6809 programs, or any software reassembled for the 6809 from existing 6800 source code. In operation, the 6809 and 6502 run concurrently, with the 6809 acting as the bus master during the 6502's bus accesses. Typically, the 6809 commands 80% of the available bus time for memory accesses and data transfers. The 6502 can stop the 6809 for time-critical I/O operations. Sections of 6502 programs can be recoded into 6809 machine language. The FLEX operating system can be employed with the Mill. The Mill features directly addressable stacks and the position independence of code, and it allows the Apple II to be used in a multiprogramming mode. The Mill is available from Stellation Two, POB 2342, Santa Barbara CA 93120, for \$275.

Circle 411 on inquiry card

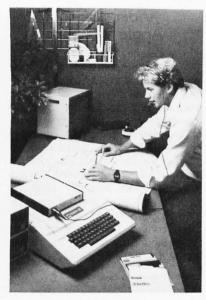
16 Megabytes of Storage on the QT

QT System + can be used for accounting, word-processing, and scientific applications. It features a Z80 microprocessor, two 8-inch floppydisk drives, a controller for doublesided, double-density 5- and 8-inch drives, and a Televideo 920C video terminal. There are 48 K bytes of dynamic programmable memory (expandable to 64 K bytes), a 2 K-byte monitor program and Disk BIOS (Basic I/O Subsystem) on an EPROM, two RS-232C ports, two parallel ports, a real-time clock, and the CP/M 2.2 or the MP/M operating systems.

The QT System+ comes in two versions. The 1-megabyte, singlesided, double-density system sells for \$4295. The 2-megabyte, doublesided, double-density unit is priced at \$4995. For complete details, contact QT Computer Systems Inc, 15620 S Inglewood Ave, Lawndale CA 90260, (800) 421-5150; in California (213) 970-0952.

Circle 412 on inquiry card

PERIPHERALS



Voice-Entry Terminal for the Apple II

The VET/2 voice-entry terminal plugs into any slot of a 48 K-byte Apple II. A direct keyboard link allows the user to choose keyboard or voice input at any time. Once a word has been entered into the program, whenever it is spoken, the function is performed. The VET/2 is supplied with preprocessor, interface board, software with demonstration programs, noise-canceling headset microphone, and a user's manual. The price is \$895 from Scott Instruments, 815 N Elm, Denton TX 76201, (817) 387-9514. Circle 413 on inquiry card

Connect Your Selectric to a Computer

The Escon interface system includes all the electronics, connectors, and instructions necessary to convert an IBM Selectric typewriter into an output printer. Units have been designed for S-100 systems, and RS-232C serial, parallel, and IEEE-488 interfaces. No drilling or modification is required. The typewriter can still be used in a normal fashion, and its eligibility for IBM warranty and service will not be affected. Printing speed is 15 cps (characters per second), which is approximately 160 words per minute. Prices range from \$595 to \$675. For details, contact Ipex International Inc, 16140 Valerio St, Van Nuys CA 91406, (213) 781-0020.

Circle 414 on inquiry card

Floppy-Disk Drives from Commodore

The 8060 series of 8-inch floppy-disk drives includes the CBM 8062, which can store 3.2 megabytes of data, and the CBM 8061, which handles up to 1.6 megabytes. The 8061 reads and writes one side of the disk, while the 8062 handles both sides. The drives and operating system are compatible with the IBM 3740 format and Commodore's other drives. For more information, contact Commodore Business Machines Inc, 950 Rittenhouse Rd, Norristown PA 19403, (215) 666-7950.

Circle 415 on inquiry card



Video Terminal from Perkin-Elmer

The Perkin-Elmer Model 550S is a block mode/editing video-display unit. Three modes allow for conversational timesharing, transaction processing, and test manipulation or software development. The 550S offers an optional second page of scrolling memory. The 24-line screen windows into 48 lines by 80 columns of text. The standard keyboard has 83 keys, including a numeric pad and four program function keys. A serial printer port is standard, as well as automatic on/off host control over terminal block transmissions and half intensity. blink, nondisplay, and protected features. Transmission types included are: send all, send unprotected only, send line, send page, and send from home to stop code. The 550S is priced at \$1189. Contact Perkin-Elmer, Terminals Division, 360 Rt 206 South, Flanders NJ 07836, (201) 229-6800.

Circle 416 on inquiry card



Pitch Analyzer for Speech Synthesis

The Visi-Pitch extracts and measures vocal pitch in real time. The device provides visual or numerical descriptions of pitch variability, speech rhythm, and intonation contours. It can be used in the testing of speech synthesis and recognition systems, and in speech therapy. The Visi-Pitch interface can transfer frequency or period information to 8-bit parallel inputs. The period data is generated after each pitch period, and frequency data is generated every 0.5 seconds. The data output is 3-state 8-bit parallel. The price for the unit is \$2410 from Kay Elemetrics Corporation, 12 Maple Ave, Pine Brook NJ 07058, (201) 227-2000.

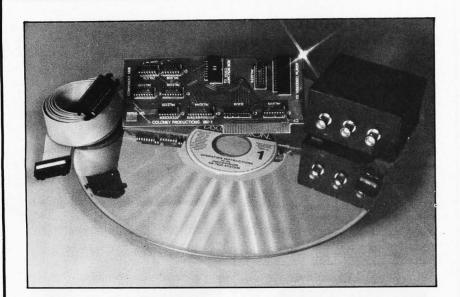
Circle 417 on inquiry card

16 K-Byte Memory Card for the Apple II

RAMCard provides the Apple II 48 K computer with 16 K bytes of programmable memory. It's compatible with Microsoft's SoftCard. It can be used with all software available for the SoftCard, but it cannot be used in addition to the Apple Language Card. The price of the RAMCard is \$195. For more details, contact Microsoft Consumer Products, 400 108th Ave NE, Suite 200, Bellevue WA 98004, (206) 454-1315.

Circle 418 on inquiry card

PERIPHERALS



Videodisk-to-Apple Interface

The Coloney VAI-1 interface board fits inside the Apple and allows complete control of the DiscoVision industrial videodisk player. In addition, the package provides circuitry to switch computer- or disk-generated video on a single television monitor. The packages sells for \$525, and includes a manual, a controller card, junction box for video connections, control subroutines in assembly language and Pascal, cables, and a demonstration program. For additional information, contact Coloney Productions, 1248 Blountstown Hwy, Tallahassee FL 32304, (904) 575-0691.

Circle 419 on inquiry card

Microcomputer-Compatible **Temperature Probes**

Tempsens provides direct temperature input for a variety of microcomputers, including the PET, the Apple II, and the TRS-80. Operating within a temperature range of -24°C to 72°C (-10°F to + 160°F), each Tempsens module provides two temperature probes to the CmC (Connecticut microComputer) AIM16 analog input module using a CmC MANMOD1. The MANMOD1 will accept input from up to 8 Tempsens modules, for a total of 16 individual probes. The suggested retail price of a 2-probe Tempsens is \$49.95. Contact Connecticut microComputer Inc, 34 Del Mar Dr, Brookfield CT 06804, (203) 775-4595.

Circle 420 on inquiry card

TEMPSENS2P -10°F TO 160°F ORK Connecticut microcomputer, inc.

Light Pen for OSI Computers

The L C S Light Pen Kit designed for OSI (Ohio Scientific) computers features a coiled cord and an easily disconnected plug. The light pen is manufactured by Lewis Computer Systems, and is distributed by Faragher Associates Inc, 7635 W Bluemound Rd, Milwaukee WI 53213, (800) 558-0870. The suggested list price is \$29.95.

Circle 421 on inquiry card

Color-Graphics Board for **Heath Microcomputers**

The HA-8-3 color-graphics board can be used with the Heath H-8 and All-In-One computers. The board uses a TI-9918 color video-display-generator integrated circuit. An AY-3-8910 programmable sound-generator circuit is also included. Four X,Y joystick consoles can be used with the board; each console has 4 bits of parallel I/O.

A socket is provided for an AMD-9511 arithmetic processor circuit. The HA-8-3 can be used with most video monitors as well as other video accessories utilizing NTSC composite color video. Demonstration software on a 5-inch floppy disk is included. The board sells for \$395. Contact Heath Company, Department 350-590, Benton Harbor MI 49022, (616) 982-3210.

Circle 422 on inquiry card

MISCELLANEOUS

This Black-Hole Diode Is User-Transparent



Another new addition in the small-components market is the 7N-∞ BHD (black-hole diode). This device has two inputs and no output. Care must be taken to shield this component appropriately or it may absorb the unit it is placed in. The 7N-∞ will accept any voltage or current value. It is useful for GI (garbage-in) applications. Due to the light-absorption qualities of the device, we could not provide a photograph. Contact Spatial Regression Ltd, POB 463, Paulborough NH 03458.

Circle 423 on inquiry card

Software for the Hayes Micromodem II

Datacomm is a data-communications-software package for use with the Hayes Micromodem II for Pascalequipped Apple II microcomputers. Datacomm consists of a terminal program that allows data and program exchange. It uses the Apple's Pascal routines for ease and accuracy, and Hayes Micromodem II routines are used so that a programmer can include data-communications commands in his or her Pascal program. Datacomm is available in retail computer stores for \$50. Contact Hayes Microcomputer Products Inc, 5835 Peachtree Corners E, Norcross GA 30092, (404) 449-8791.

Circle 424 on inquiry card

Low-Power 16 K-Byte Memory Board for S-100 Systems

This 16 K-byte programmable memory board for S-100-bus systems uses 650 mA at +5V, 90 mA at +12V, or 16 mA at -5V. Each 4 K-byte block is addressable to any 4 K boundary. The board uses NEC (Nippon Electric Company) UPD 410 D integrated circuits. This static memory board costs \$350 in kit form, or \$385 assembled. Contact Shell Electronics Company, M/S 1429, Sun Valley CA 91352, [213] 767-5597.

Circle 425 on inquiry card

S-100 Error-Correcting Board

This 4 MHz S-100 error-correcting board monitors 64 K bytes of existing system programmable memory and intervenes to correct bus data before it is accepted by the microprocessor. The board corrects 1-bit memory errors and flags all 1- or 2-bit errors. All operations are performed through onboard hardware. The board immediately corrects memory problems, and latched displays show the address and bit in error. The price is \$1295 from Correlation Systems, 81 Rockinghorse Rd, Rancho Palos Verdes CA 90274.

Circle 426 on inquiry card

Z80 Monitor in an EPROM

SSM Microcomputer Products has a Z80 monitor in a single-voltage 2716 EPROM. Supporting SSM's CB2 Z80 microcomputer board, the monitor allows operators to display, substitute, or fill memory; perform hexadecimal arithmetic; establish two program breakpoints; set and examine registers; assign I/O devices; and input and output data to or from a port. The monitor can scan its memory and set its stack to avoid replacement or reprogramming of the EPROM. Documentation and software listings are provided with the monitor, which is priced at \$89. Contact SSM Microcomputer Products, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400.

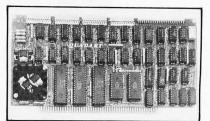
Circle 427 on inquiry card

Apple II Display Board

The Apple II Display Board has a run-stop, single-step switch that simplifies identification of shorted lines between address or data bits and shows individual steps for teaching computer logic. The board has 16 address LEDs (light-emitting diodes), 8 data LEDs, and 1 ready LED. All lines are buffered. The board sells for \$49.95 assembled and tested, \$42.95 for the kit, and \$25.95 for the bare board. Contact John Bell Engineering, POB 338, Redwood City CA 94064, (415) 367-1137.

Circle 428 on inquiry card

Serial-Communications Card for S-100 Systems



Cromemco's Quadart serial-communications S-100 interface card has four serial channels. Any channel can support asynchronous or synchronous byte- or bit-mode communication protocols under software control. Handshaking is provided. The Quadart can connect an S-100 microcomputer and an IBM-type machine using Bisync or SDLC protocol. A loopback feature provides the capability to connect data from one channel or modem to another, or allows any modem/channel combination to be used. Data rates range from 0 to 300 k bps (bits per second). The interface supports the interrupt structure of the Z80A microprocessor. The Quadart has real-time clocking capability. Control for the board is from the C-Bus provided by Cromemco's Model IOP processor computer. The Quadart serial-communications board is available for \$595. The IOP costs \$695. For information, contact Cromemco Inc, 280 Bernardo Ave, Mountain View CA 94043, (415) 964-7400.

Circle 429 on inquiry card

WordCheck Spots Misspellings in Documents and Letters

WordCheck interacts with Word-Pro 3 or 4 word-processing programs and checks every word for spelling or typographical errors. The program contains approximately 2000 of the most commonly used words and suffixes. Words that do not match this list appear on the screen. If you wish, these words can then be added to a 1000-word auxiliary spelling list. WordCheck is available for CBM and PET 32 K-byte microcomputers with floppy-disk drives. The list price is \$200 from Micro Computer Industries Ltd, 1520 E Mulberry, Suite 110, Fort Collins CO 80524, (303) 221-1955.

Circle 430 on inquiry card

MISCELLANEOUS



Copy Stands for Computer Terminals

The Keyboard Companion copy stands keep work directly in front of the operator. They fit most terminals with detachable keyboards, including the Apple II. The units can support a telephone book and other heavy reference manuals or manuscripts. Installation is quick and easy. Prices begin at \$19.95 for the 16-inch model. For information, contact PKay Corporation, POB 11463, Costa Mesa CA 92627, (714) 548-2081.

Circle 431 on inquiry card

Zilog's New Microcomputer Systems

The MCZ 2/19 features a Z80A microprocessor, 64 K bytes of programmable memory, and 2.4 megabytes of floppy-disk storage that can be expanded to 4.8 megabytes with additional disk drives. The MCZ 2/49-1 system includes the MCZ 2/19 plus a video-display terminal, Zilog's RIO 3 operating system, and COBOL or BASIC. Zilog also has PLZ and a variety of business-application software packages available. In 50-unit quantities, the MCZ 2/49-1 costs \$5890, and the MCZ 2/19 is \$5270. For details, contact Zilog, 10340 Bubb Rd, Cupertino CA 95014, (408) 446-4666.

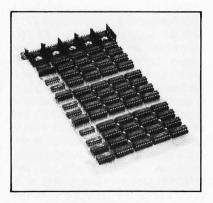
Circle 432 on inquiry card



Noise-Emitting Diode from L O U D

The 3N12ODB NED (noise-emitting diode) is a new development in indiscreet electronics. It is pictured in a DO-4 case. It is a low-voltage, high-power device with a + 3dB signal-tonoise ratio. The NED is available from LOUD Electronics, POB 463, Wheelborough NH 03458.

Circle 433 on inquiry card



Memory Board for SS-50 Bus Works with 1-Megabyte Memory Systems

A 24 K-byte static programmable memory board for SS-50 bus systems, the M24SS is available in 8 K-, 16 K-, and 24 K-byte configurations. The board is organized in 8 K-byte seqments that can be located at any 8 Kboundary of a 64 K-byte memory space. The board uses standard 2114 integrated circuits. Access time is 300 ns. The 8 K-byte configuration is \$199.95, the 16 K- is \$349.95, and the 24 K- is \$499.95. A memory expansion kit is available for \$139.95. For complete details, contact Percom Data Company, 211 N Kirby, Garland TX 75042, (800) 527-1592; in Texas (214) 272-3421.

Circle 434 on inquiry card

Control AC Circuit Devices from Your Apple II

This I/O (input/output) interface board for the Apple II can operate up to 256 BSR System X-10 AC control modules. Input communications come from the X-10 command console and temperature and security input modules, which will soon be available from Intelligent Control Systems. On-board software is provided to handle the AC I/O. The software also coordinates the background schedule-control process and sets, reads, and displays the real-time clock. Four selectable interrupt rates allow the simultaneous running of machine-language programs in the background and other programs in foreground. A rechargeable battery powers the clock when the Apple is off. The price is \$185 from Intelligent Control Systems Inc, POB 14571, Minneapolis MN 55414, (612) 699-4342.

Circle 435 on inquiry card

Multitasking System for Dynabyte 5000 Microcomputers

DOS Level 4 is a multitasking operating system for Dynabyte's Series 5000 microcomputers. This CP/Mand MP/M-compatible system is available on all Dynabyte microcomputers. It can handle up to 8 terminals and 16 printers, and any single terminal can run up to 8 simultaneous jobs. Any printer can be accessed from any terminal, and each terminal can have or share a single system spooler. Memory capacity is 400 K bytes.

DOS Level 4 supports MBASIC, CBASIC, COBOL, FORTRAN, PL/I, and Pascal. The package includes interfacing software, a driver for a modem, and a utility to help programmers create interface drivers for special peripherals. For information, contact Dynabyte Inc, 115 Independence Dr, Menlo Park CA 94025, (800) 227-8300; in California (415) 329-8021.

Circle 436 on inquiry card

MISCELLANEOUS

Release Wire Ties



Courtesy Plastics has wire ties that feature release levers molded into locking heads. Squeezing this lever allows the tie to be adjusted or removed without damaging it. The tie can be reused later. These ties may be installed by hand or machine. They come in sizes for bundles up to 5 cm (2 inches) in diameter. The Release Wire Tie has a tensile strength of 50 lbs. For complete details, contact Courtesy Plastics, 250 Alice St, Wheeling IL 60090, (312) 541-7900. Circle 437 on inquiry card

Apple Users' Work Collected in Catalog

The Special Delivery Software Catalog program offers a selection of user-written programs for the Apple computer. This catalog program is designed by Apple to encourage people outside the company to develop software and to make their applications programs available to other Apple users. The first catalog contains 12 programs, including a personal-finance manager, a BASIC teaching program, stepwise multiple regression, programs for learning geometry and measurement, games, a Pascal animation package, a Pilot animation program, electronic music, and a US geography package. Software prices are in the \$35 to \$150 range. Apple plans to update the catalog three times annually. To order the free catalog or the software from it, call (800) 538-3088; in California call (800) 662-9256. To submit programs for evaluation by Apple, write to Special Delivery Software, 10260 Bandley Dr, Cupertino CA 95014. Circle 438 on inquiry card

Color Graphics Printer

The Model IS8001 is a color graphics printer produced by Printa-Color Corporation. The device contains a microprocessor and features a twelve-nozzle, three-color ink-jet printhead that can print seven colors using two- or three-color overlays. The print head has a resolution of 100 dots per inch. The microprocessor enables the unit to present minimal burden to the host computer. The IS8001 can print on 14%-inch paper with 70 characters per line. For further details on this \$6000 color printer, contact PrintaColor Corporation, 5965 Peachtree Corners E, Norcross GA 30071, (404) 448-2675.

Circle 439 on inquiry card

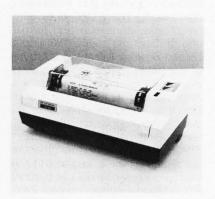


To uch-Sensitive Kits for Video Displays

Interaction Systems Inc's touchsensitive add-on kits can be attached to any 12- or 15-inch (diagonal) video screen. Data can be entered on the screen by touching the appropriate area of the screen. The kits utilize a capacitance-sensitive faceplate, which is mounted in front of the video screen. Software and firmware allow the computer to identify and interpret the changes in capacitance. The faceplate interface uses a Z80 microprocessor. Custom configurations are available. The kits are priced under \$300 in OEM (original equipment manufacturer) quantities. Contact Interaction Systems Inc, 24 Munroe St, Newtonville MA 02160, (617) 244-6825.

Circle 440 on inquiry card

Inexpensive **Dot-Matrix Printer**



The GP-80M is an 80-column, 5 by 7 dot-matrix printer having an upperand lowercase ASCII (American Standard Code for Information Interchange) set, double-width characters, and dot graphics modes. The printhead life is 30 million characters. Print speed is 30 cps (characters per second), with original-plus-two copies capabilities and adjustable tractors to accommodate paper widths up to 8 inches. It measures 171 by 328 by 127 mm (7 by 13 by 5 inches) and weighs 2.5 kg (51/2 lbs). Parallel and serial interfaces are available. The suggested retail price is \$425. Contact Watson, Burton, and Associates, Port POB 122, Yokohama 231-91, Japan, Telex 3822596.

Circle 441 on inquiry card

Plug Centronics 737 Printer into the H89/Z89

This interface board allows the Centronics 737 printer to be used with the Heath/Zenith H89/Z89 microcomputer. It plugs into either machine's internal bus, and can use any of the four decoded I/O ports. The HDOS device driver provides access to the printer's features, which include underscoring; elongated, proportional, condensed, or standard print fonts; sub- and superscripting; backspace; and half or full, forward or reverse line feeds. The interface and HDOS device driver together are \$64.95. Separately, the driver is \$14.95, and the interface is \$54.95. Order from FBE Research Company Inc, POB 68234, Seattle WA 98168.

MISCELLANEOUS

Universal Peripheral Controller for the Z8000

Zilog's Z8090 Universal Peripheral Controller (Z-UPC) is designed for distributed processing and multitasking applications. The Z-UPC does arithmetic tasks, translation and formatting of data, and controls I/O (input/ output) devices. It features 2 K bytes of internal ROM (read-only memory), externally expandable from 2 to 4 K. Also included is a 256-byte register file, three programmable 8-bit I/O ports, two counter/timers, and six levels of internal prioritized interrupts. The device is offered in four other versions, and all are priced at \$117.36 each, in sample quantities of 10 to 99. For additional details, contact Zilog, 10340 Bubb Rd, Cupertino CA 95014, (408) 446-4666.

Circle 443 on inquiry card

Atari 400 and 800 Screen Printer

The Macrotronics screen-printer package enables users to print an Atari 400's or 800's screen display onto a Trendcom 200 or IDS 440G Paper Tiger printer. Text, graphs, and drawings can be printed, and the image can be printed in gray-scale, black-and-white, and reversed image. LPRINT and LIST"P:" commands are used to print. The package includes a connector assembly with a cable and a 3 K-byte auto-loading program on floppy disk and cassette. Listings of sample programs are included in the user's manual. The package is priced at \$139, from Macrotronics Inc., 1125 N Golden State Blvd, Suite G, Turlock CA 95380, (209) 667-2888.

Circle 444 on inquiry card

Novation Has LSI Modem Modules

These modem modules can operate at rates up to 1200 bps (bits per second) and are designed for building-block applications within computers or terminals. The modules can provide Bell 202 half-duplex, Bell 103 answer/originate, CCITT European Standards V.21 or V.23, ViewData European Network, and interface with the deaf teletypewriter (TTY) network. Contact Novation, 18664 Oxnard St, Tarzana CA 91356, (213) 996-5060.

Circle 445 on inquiry card



Extremely Fast Schottky PROMs

Using a titanium/tungsten technique, Monolithic Memories Inc has developed a series of fast Schottky 1 K- and 2 K-bit bipolar PROMs (programmable read-only memories). These devices use a programming technique that doesn't require a separate programming pin. Available in 256- by 4-bit, and 516- by 4-bit configurations, the PROMs feature PNP inputs for low-input current, full Schottky clamping, and three-state or open-collector outputs. They operate

TI Extended BASIC and Memory Expansion Unit

TI Extended BASIC is an expanded version of the resident BASIC in Texas Instruments' TI-99/4 microcomputer. It features ACCEPT AT and DISPLAY AT statements, sprites (programmable moving objects), subprograms, and error-handling functions. Multiple statements can be written on the same line with tail-end remarks. Complex IF...THEN...ELSE statements can also be written.

The Memory Expansion Unit is exclusively designed for use with Extended BASIC or UCSD Pascal, Version IV, which is newly available. The unit adds 32 K bytes of programmable memory to the 16 K bytes resident in the TI-99/4. For more information, contact Texas Instruments Inc. Consumer Relations, POB 53, Lubbock TX 79408, (800) 858-4565; in Texas (800) 692-4279.

Circle 447 on inquiry card

at 45 ns for commercial and 55 ns for military devices. In lots of 100, each 63S140/1 commercial 1 K-bit PROM costs \$5; the military 53\$140/1 is \$7.50. In similar quantities, the 2 K-bit PROMs are \$7.50 and \$11.25 each. Contact Monolithic Memories Inc, 1165 E Arques Ave, Sunnyvale CA 94086, (408) 739-3535.

Circle 446 on inquiry card

Fujitsu America's 8-Inch Winchester Disk Drives

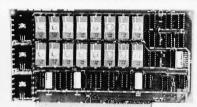
The Model 2311 8-inch Winchester disk drive stores 48 megabytes and the Model 2312 84 megabytes; both feature a 20 ms access time. The 2311 uses two hard disks for storage, and the 2312 stores its 84 megabytes on four disks, utilizing 589 cylinders at 20 K bytes per track. An SMD interface with data-separation circuitry and internally selectable fixed- and variablelength sector formats are provided. The price of the 48-megabyte 2311 is \$3195 in OEM (original equipment manufacturer) quantities of 100, and the 84-megabyte 2312 drive is \$3795 in the same quantities. The Fujitsu Model 2301 floppy-disk drive stores 11.7 megabytes and is priced at \$1660 in OEM quantities of 100. The 2302 floppy-disk drive stores 23.4 megabytes and is priced at \$2095 in OEM quantities. For additional information, contact Fujitsu America Inc, 2945 Oakmead Village Ct, Santa Clara CA 95051, (408) 727-4300.

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32K S-100 EPROM CARD



USES 2716's

Blank PC Board - \$34 **ASSEMBLED & TESTED** ADD \$30

SPECIAL: 2716 EPROM's (450 NS) Are \$11.95 EA. With Above Kit.

KIT FEATURES

- Uses +5V only 2716 (2Kx8) EPROM's.
- Allows up to 32K of software on line!
- IEEE S-100 Compatible
- Addressable as two independent 16K blocks
- Cromemco extended or Northstar bank select
- 6. On board wait state circuitry if needed. 12. Easy and quick to assemble.
- 7. Any or all EPROM locations can be disabled.
- 8. Double sided PC board, solder-masked silk-screened
- 9. Gold plated contact fingers
- 10. Unselected EPROM's automatically powered down for low power.
- 11. Fully buffered and bypassed.

32K SS-50 RAM

\$37900

For 2MHZ

Add \$10 Blank PC Board \$50

For SWTPC 6800 - 6809 Buss

> Support IC's and Caps \$19.95

Complete Socket Set \$21.00

Fully Assembled Tested, Burned In Add \$30

NEW!

At Last! An affordable 32K Static RAM with full 6809 Capability.

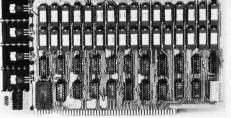
FEATURES:

- 1. Uses proven low power 2114 Static RAMS.
- 2. Supports SS50C EXTENDED ADDRESSING.
- 3. All parts and sockets included.
- 4. Dip Switch address select as a 32K block.
- 5. Extended addressing can be disabled.
- 6. Works with all existing 6800 SS50 systems.
- 7. Fully bypassed. PC Board is double sided, plated thru, with silk screen.

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!

FOR 4MHZ



KIT FEATURES

- Addressable as four separate 4K Blocks.
 ON BOARD BANK SELECT circuitry. (Cromemco Standard'). Allows up to 512K on line!
- Uses 2114 (450NS) 4K Static Rams ON BOARD SELECTABLE WAIT STATES.
- 5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers
- All address and data lines fully buffered.
 Kit includes ALL parts and sockets.
- PHANTOM is jumpered to PIN 67. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss
- 10. Blank PC Board can be populated as any multiple of 4K

BLANK PC BOARD W/DATA-\$33

LOW PROFILE SOCKET SET-\$12 SUPPORT IC'S & CAPS-\$19.95

ASSEMBLED & TESTED-ADD \$35

COMPLETE KIT!

\$8495

(WITH DATA MANUAL)

BLANK PC

BOARD W/DATA

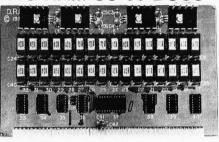
OUR #1 SELLING RAM BOARD!

16K STATIC RAM SS-50 BUSS

PRICE CUT!

FULLY STATIC!

FOR 2MHZ **ADD \$10**



FOR SWTPC 6800 BUSS!

ASSEMBLED AND TESTED - \$35

KIT FEATURES

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- Uses 2114 Static Ram
- Fully Bypassed
 Double sided PC Board. Solder mask
- and silk screened layout All Parts and Sockets included
- Low Power: Under 1.5 Amps Typical

BLANK PC BOARD-\$35

COMPLETE SOCKET SET-\$12 SUPPORT IC'S AND CAPS-\$19.95

STEREO! NEW! S-100 SOUND COMPUTER BOARD

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY3-8910 NMOS computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

KIT FEATURES:

* TWO GI SOUND COMPUTER IC'S.

* FOUR PARALLEL I/O PORTS ON BOARD.

* USES ON BOARD AUDIO AMPS OR YOUR STEREO.

* ON BOARD PROTO TYPING AREA.

* ALL SOCKETS, PARTS AND HARDWARE ARE INCLUDED.

* PC BOARD IS SOLDERMASKED, SILK SCREENED, WITH GOLD CONTACTS.

* EASY, QUICK, AND FUN TO BUILD. WITH FULL INSTRUCTIONS.

* USES PROGRAMMED I/O FOR MAXIMUM SYSTEM FLEXIBILITY.

USES PROGRAMMED I/O FOR MAXIMUM SYSTEM FLEXIBILITY.

Both Basic and Assembly Language Programming examples are included.

SOFTWARE:

SCL" is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL" also includes routines for Register-Examine-Modify, Memory-Examine-Modify, and Play-Memory, SCL" is available on CP/M' compatible diskette or 2708 or 2716 is bactle on CP/M' compatible diskette or 2708 or 2716 or 2716

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(With Pin Out Data #5280-5N 4096 BITS x 1 270 NS ACCESS 8 FOR \$4.95 32 FOR \$16

FACTORY CASE (450 PCS) - \$180 Sockets Special: 22 Pin Low Profile (With Purchase of 5280's) 8 FOR \$1.

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AY3-8910. As featured in July, 1979 BYTE! A fantastically powerful Sound & Music Generator. Perfect for use with any 8 Bit Microprocessor. Contains: 3 Tone Channels. Noise Generator, 3 Channels of Amplitude Control. 16 bit Envelope Period Control, 2-8 Bit Parallel I/O. 3 D to A Converters, plus much more! All in one 40 Pin DIP. Super easy interface to the S-100 or other busses. **\$11.95 PRICE CUT!** \$11.95

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SOFTWARE

CP/M for Heath Microcomputers

Heath H-8 and H-89 All-In-One computers can now have the CP/M operating system. Three operating system modules (BIOS, BDOS, CCP) are included with Heath CP/M. Utilities included are a two-pass 8080 assembler; a text editor; an 8080 debugger with traced execution and disassembly; a file dump; system generation and relocation; programs to display file sizes and disk usage, set file class, assign physical and logical devices, display system parameters, copy files between devices, and convert internal HEX files into memory images. Full source code is provided. The Heath CP/M operating system comes on 5- and 8-inch floppy disks for \$150. For details contact, Heath Company, Department 350-620, Benton Harbor MI 49022, (616) 982-3210.

Circle 449 on inquiry card

Accountant's Software

DATAWRITE is a CP/M-based client-write-up program for accountants. It supports floppy- and hard-disk drives and incorporates expanded account-number structures, several journal options, and complete report-writing capabilities. For details on DATAWRITE, contact Dataword Inc, 1404 140th PI NE, Bellevue WA 98007, (206) 643-2050.

Circle 450 on inquiry card

Interface CBASIC With AssemblyLanguage Programs

CBASIC, Version 2, incorporates a function that allows assembly-lanquage packages to be interfaced with CBASIC programs. It permits trace outputs to the console when a lineprinter statement is in effect. It provides for 255 characters to be entered in response to an input statement. A backslash within a data statement is treated as a literal character rather than a continuation character. CBASIC features 14-digit accuracy for business applications, and is implemented as a compiler. It allows a text editor to be used. CBASIC, Version 2, was developed by Compiler Systems, POB 145, Sierra Madre CA 91024, (213) 355-1063. Circle 451 on inquiry card

Cribbage for the TRS-80

Cribbage Master plays a strong game, pegging its own points in play and never missing an opportunity to score—especially on points you miss. The program shows the order of the cards as played for in-play pegging. All entries are made by a single keystroke. Cribbage Master is designed for the TRS-80 16 K-byte Level II. It is available from Manhattan Software, POB 35, Pacific Palisades CA 90272, (213) 454-8290, for \$12.95.

Circle 452 on inquiry card

Software for Z80, 8080, and 8085 Systems

The ZAPS software system has assemblers and disassemblers for Z80, 8080, and 8085 systems. An editor, loader, and the use of Intel and Zilog-Mostek mnemonics are also featured. The system requires any Z80 processor with a North Star floppy-disk drive, and 48 K bytes of programmable memory. The price is \$100 from Conentropy, POB 316, Yonkers NY 10704.

Circle 453 on inquiry card

6800 Diagnostics and Disk Repair

Technical Systems Consultants Inc has a memory-diagnostic and disk-repair package for the 6800 microprocessor. The programs run under the 6800 FLEX operating system. Included in the memory diagnostics are a 0s and 1s test, a random pattern test, walking bit tests, a dynamic programmable-memory dropout test, and a convergence test.

The disk-repair portion contains utilities that operate on a FLEX-formatted floppy disk. There are three diagnostic utilities that report unreadable sectors and structural inconsistencies among files, two utilities for recovering data, a utility to remove bad or intermittent sectors from the free space, a program to retrieve deleted files, a single-sector read/write/modify routine, and a copy utility which ignores CRC (cyclic redundancy check) errors. This package is available on 5or 8-inch floppy disk for \$75. Contact Technical Systems Consultants Inc, POB 2570, 1208 Kent Ave, West Lafayette IN 47906, (317) 463-2502. Circle 454 on inquiry card

Three Versions of FORTH for OSI

Starstruck Software has fig- (FORTH Interest Group) compatible FORTH for OSI (Ohio Scientific) C8P dual floppy-disk-drive systems. A line editor, commands for the OS65D operating system, and a record of unused dictionary space are featured. This version costs \$79.95. Contact Back to Basic Computer Center, #43 Cross Keys Shopping Center, Florissant MO 63033, (314) 873-4495.

OSI-FORTH 2.0 runs under the OS-65D3 operating system, and has access to all commands and resources. A 6502 assembler and a text editor are included. OSI-FORTH 2.0 runs on C2, C3, C4, and C8 systems. It is supplied on 5- or 8-inch floppy disks, and has a suggested price of \$79.95. For details, contact Technical Products Company, POB 12983, University Sta, Gainesville FL 32604.

TEK-AIDS' OS65U fig-FORTH uses the OS65U operating system and runs coresident with BASIC, allowing FORTH modules to be integrated into existing programs. OS65U will run on OSI 48 K-byte systems with dual disk drives or hard-disk and multi-user configurations. The price for this system is \$250. Contact the Software Federation Inc, 44 University Dr, Arlington Hts IL 60004, (312) 259-1355.

Circle 455 on inquiry card

New Games for the Apple II

The Apple now has three new high-resolution-graphics games written in machine language: Asteron, Star Avenger, and Shooting Gallery. They run on the Apple II under all versions of DOS (disk operating system) and on the Language System. Each game is supplied on a disk and requires 48 K bytes of memory. Shooting Gallery costs \$22.50, and the others are priced at \$27.50. Contact Western MicroData Enterprises Ltd, POB G33, Postal Station G, Calgary, Alberta, T3A 2G1, Canada.

Circle 456 on inquiry card

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Family Disk Drive System

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Letter Quality



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- 9 x 7 dot matrix
- 125 cps bi-directional print speed
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- NEW! Uses latest State of the Art LSI Technology
- Requires only one slot for 9 voices!
- Uses three AY3-8910's to produce 9 voices
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- Completely packaged system, tested and ready to plug in
- Includes: power supply, two 40 track drives, case, double density controllers, and all cabling and total CP/M™ documentation.
- Storage capacity from 400K to 1.2 meg.

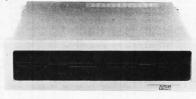
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- Deluxe chassis with internal slide allows easy access for drive positioning and mounting.
- Built to mechanically and electrically accomodate single sided drives, double sided drives - including, the most popular 8-inch Winchester and Shugart floppy disk drives, and 8-inch streaming tape cartridge units.

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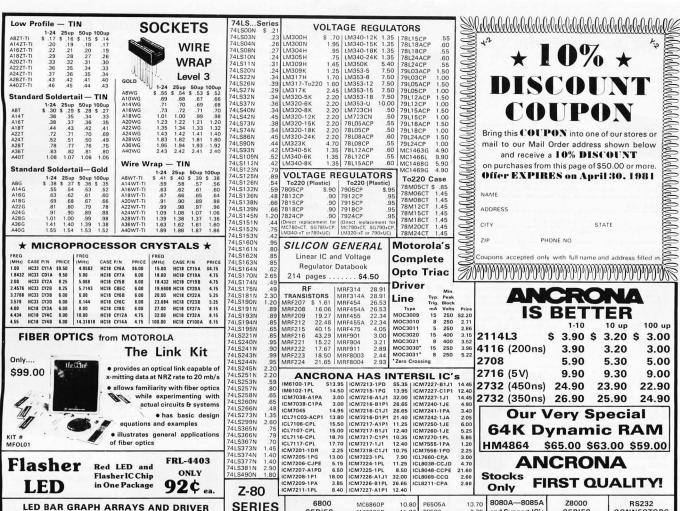
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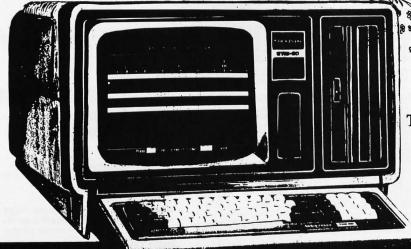
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Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The Super Elf includes a ROM monitor for program loading, editing and execution with SINGLE STEP for program debugging which is not in-cluded in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing in-structions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes

A 24 key HEX keyboard includes 16 HEX keys

Super Expansion Board with Cassette Interface \$89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board** comes with 4K of low power RAM fully address-able anywhere in 64K with built-in memory pro-tect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes. A IK Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability video graphics driver with blinking cursor. Break

Quest Super Basic V5.0

Quest Super Basic V5.U
A new enhanced version of Super Basic now
available. Quest was the first company
worldwide to ship a full size Basic for 1802
Systems. A complete function Super Basic by
Ron Cenker including floating point capability
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Gremlin Color Video Kit \$69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit \$4.95

1802 16K Dynamic RAM Kit \$149.00 Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM \$63.00 Tiny Basic Extended on Cassette \$15.00 (added commands include Stringy, Array, Cas-sette I/O etc.) S-100 4-Slot Expansion \$ 9.95 Super Monitor VI.I Source Listing \$15.00

plus load, reset, run, wait, input, memory pro-tect, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connec-tor slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 127 pg, instruc-tion manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf Kit \$106.95, High address option \$8.95, Low address option \$9.95. Custom Cabinet with drilled and labelled plexiglass front panel \$24.95. All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply \$57.00. NiCad Battery Memory Saver Kit \$6.95. All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for \$12.00 per 12 issues. Single issues \$1.50. Issues 1-12 bound \$16.50.

Tiny Basic Cassette \$10.00, on ROM \$38.00, original Elf kit board \$14.95. 1802 software; Moews Video Graphics \$3.50. Games and Music \$3.00. Chip 8 Interpreter \$5.50.

points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include Parallel Input

and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two S-100 slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. Parallel I/O Ports \$9.85, RS 232 \$4.50, TTY 20 ma I/F \$1.95, S-100 \$4.50. A 50 pin connector set with ribbon cable is available at \$15.25 for easy connection between the Super Elf and the Super Expansion Board.

Power Supply Kit for the complete system (see Multi-volt Power Supply).

sette I/O; save and load, basic, data and ma-chine language programs; and over 75 state-ments, functions and operations. New improved faster version including re-number and essentially unlimited variables. Also, an exclusive user expandable command library.

library.
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LRC 7000 printer interface cable for Super Elf

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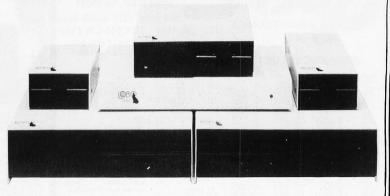
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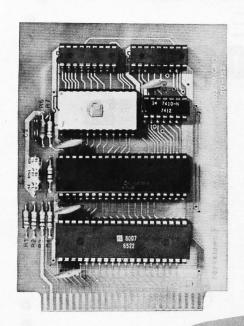
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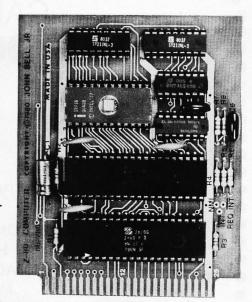


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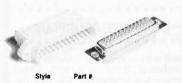


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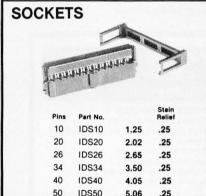
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4.0"	1.42	4.44	7.94	8.0"	2.14	7.38	13.73					500	4"	500	6"
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								500	3"	100	51/2"	1000	3"	1000	5"
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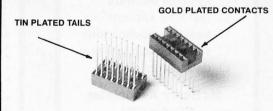
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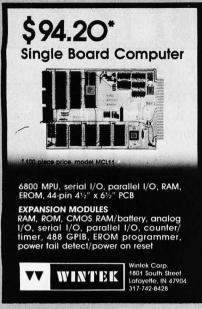
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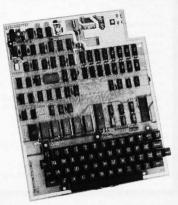


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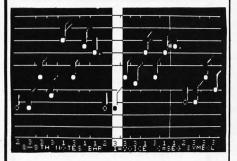
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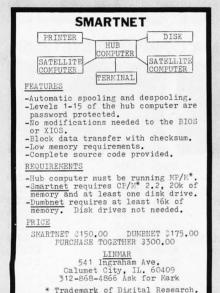
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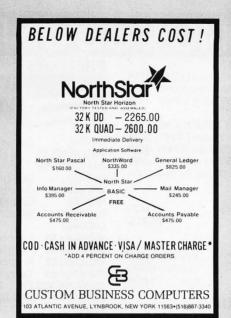
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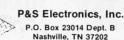
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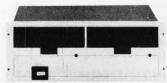
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4009						.89	4047					2.75
4010						.85	4049					.89
4011						.69	4050					.89
4013						.85	4051					1.95
4016						.85	4066					1.19
4017						1.49	4069					.79
4018						1.49	4070					.79
4020						2.19	4071					.79
4023						.49	4081					.69
4024						1.29	4093					1.19
4027						.89	4511					1.95

CONNECTORS

REGULATED POWER SUPPLY KIT

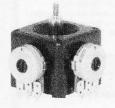


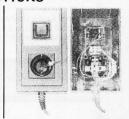
DESK TOP ENCLOSURES



DTE-8	(Pictur	ed)													\$31.95
DTE-11	(Pictur	ed)													34.95
DTE-14															36.95
DTE-HK															
DTE-AK	(Case	for	JE	6	1	0)	(Pi	CI	tu	re	d)		52.95

JOYSTICKS





JS-100K	100K Linear Taper Pots .			\$5.49
JVC-40	40K (2) Video Controller			5.95

DB25P D-Subminiature Plug D-Subminiature Plug D-Subminiature Socket Cover for DB25P/S P.C. Edge BNC Plug BNC Jack UHF Adapter UHF Panel Recp. UHF Adapter UHF Plug BNC Plug BNC Plug 4.95 2.25 2.95 2.19 3.95 DB25S DB51226 22/44SE UG 175/U S O 239 P L 258 P L 259 1.95 1.95 UG260/U BNC Plug UG1094/U BNC Bulkhead Recp.

	TOOLS
10	
1000	
19	
	*

LINEAR THE												
LM301N.				.59	LM78	805T				1.75		
LM305H.				1.39	LM78	312T				1.75		
LM307N.				.75	LM78	15T				1.75		
				1.19	LM38	10N.				1.49		
LM309K.				2.25	LM38	14N.				2.49		
LM310N.				2.69	LM55	5N.				.69		
LM311N.				1.49	LM55	6N.				1.49		
LM317T.				2.29	LM56	5N.				1.95		
LM318N.				2.95	LM56	6N.				1.95		
LM319N.				2.95	LM56					1.79		
LM320K-5				2.25	LM72	3N.				.79		
				1.75	LM74	1N.				.65		
LM7912T				1.75	LM13	10N				2.95		
LM7915T				1.75	LM14	58 N				.99		
LM323K.				5.95	LM14	V188				1.59		
LM324N.				1.29	LM14	89N				1.59		
LM337T.				2.29	LM18	N00				4.49		
LM339N.				1.29	764771	٧				3.95		

CB-3	P.C. Board Vise \$	12.49
VS-150	5"Wire Strip./Cut. (12-24AWG)	3.99
G-30	10" 110-120V 30W Solder Iron	7.50
G-TIP	Replacement Tip for SG-30 S. Iron	1.25

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AC250	250mA	12VAC	(117V/60Hz)		\$3.95
DV9200	200mA	9VAC	(117V/60Hz)		3.95

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	ILLIII.
Low Profile 8 pin LP 2/.59	Wire Wrap
8 pin LP 2/.59	14 pin WW tin .75
14 pin LP 2/.69	14 pin WW gold 1.09
16 pin LP 2/.79	16 pin WW tin .79
18 pin LP 2/.89	16 pin WW gold 1.19
20 pin LP 2/.99	24 pin WW gold 1.69
22 pin LP2/1.09	40 pin WW gold 2.75
24 pin LP79	14 p. plug/cover 1.29
22 pin LP 2/1.09 24 pin LP	16 p. plug/cover 1.39
36 pin LP99	24 p. plug/cover 1.95
40 pin LP 1.19	Also, The Molex Line

DI	0	D	1	ES	S	& T	R	14	IS	1	S	T	0	F	RS
IN751						2/.59	2	N	219	F	١.			.:	2/1.19
IN757															2/.89
IN1188						2.69									2/.89
IN3600).					5/.99	2	N3	3055	j.					.99
IN4001						4/.59									2.25
IN4004						4/.69									2/.69
IN4007						4/.79									2/.69
IN4148						10/.99									2/.79
IN4733						2/.69		21/4							2/.79
IN4734						2/.69		21/2							2/.69
IN4735						2/.69		21/2							2/.69
IN4742						2/.69									2/.79
IN4744						2/.69	2	2115	95	١.				.:	2/1.29

	C	: /	APAC	ITORS	S		П	
٠		٠	2/.69	2N5951.	٠	٠	٠	.2/1.29
			27.09	2145210.				

CAPACITORS				
Dipped Tantalum		ELECTROL\	TIC	
.1mfd@35V	2/.89	lmfd@50V	3/.69	
.47mfd@35V	2/.89	4.7mfd@50V	2/.59	
lmfd@35V	2/.89	10mfd @50∨	2/.69	
2.2mfd@25V	2/1.09	22mfd@50V	2/.79	
3.3mfd@25V	2/1.19	47mfd@50V	2/.89	
4.7mfd@25V	2/1.39	100mfd@50V	.59	
10mfd@25V	1.19	220mfd@50V	.69	
33mfd@25V	3.95	1000mfd@25∨	1.19	
100V MYI	LAR	2200mfd@16V	1.39	
.00101mfd	4/.79	50V CERA	MIC	
.022mfd	4/.89	10pf022mfd	4/.59	
.047mfd	4/.99	.047mfd	4/.69	
.lmfd	4/1.19	.1mfd	4/.79	
.22mfd	4/1.29			

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Z80A	CPU (4MHz)	14.95
MC6800	8 Bit MPU	14.95
8080A	CPU	7.95
8212	8 Bit I/O Port	3.95
8216	Bi-Directional Bus Driver	4.49
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The TIME MACHINE communicates with your computer via a serial I/O port at a user selectable data rate between 300 and 2400 baud, RS-232, RS-422, or current loop communication may be used.

Battery protection against power loss is included. The TIME MACHINE automatically computes day of the week and leap year. Buffered output pulses at one second, one

Dimensions are $2.5 \times 4.75 \times 7.5$ inches. Batteries, ver supply, and communication cable are included

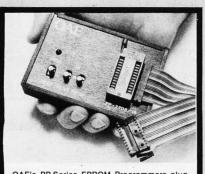
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Circle 335 on inquiry card.



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A professional Z-8000 assembly language package now available for 8080 & Z-80 based microcomputers which use the CP/M* or ISIS-II* operating system. The package includes:

ZAS Full featured relocatable cross assembler. Uses Zilog syntax, supports segmented and non-segmented code, symbol names to 64 characters. 26 directives, including nested conditional assembly, "include" files, and named program, data and absolute sections. Outputs: object and listing files.

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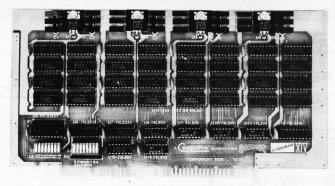
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ANOTHER FAMOUS PRIORITY 1 ELECTRONICS TRUCK LOAD PURCHASE 10 MHZ 16K A&T STATIC S-100 RAM **FROM**

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The RAM 14 provides 16K X 8 of reliable, totally static RAM storage. Conforming fully to the IEEE 696/S-100 bus standard, RAM 14 not only provides 24 address lines for 16 megabyte extended addressing capability, but also includes a number of features you would only expect to find in memory boards costing considerably more larger a partial listing of what makes RAM 14 your more. Here's a partial listing of what makes RAM 14 your best choice!

- Operates up to 10 MHZ (70 ns Ram Chips)
- Assembled & Tested
- Meets or exceeds all IEEE 696/S-100 specifications (including timing).
- Fully static design eliminates the timing problems associated with dynamic memories.

 Switch selectable choice of 24 address lines conforming to the IEEE 696/S-100 extended addressing specifications, or 16 address lines as used in older S-100 systems.
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- Board is addressable as one 16K x 8 block on any 4K boundary. Switch selectable PHANTOM disable and write protect.
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- Low power operation (900 mA typical, 1200 mA maximum). 1 year Factory Warranty

GBT-143A \$199.00

Quantities are limited so hurry!



Terms: Visa, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6% sales tax. *Sales Prices are for prepaid orders only. Credit card orders will be charged appropriate freight.

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* Extended Address Lines A16 - A17

* Phantom Line

PINS

8

16

18

20

24

28

40

1.0

4.7

6.8

10

15

22

27

33

47

14

10

.13

.16

.18

.22

.32

.34

.45

75

100

150

220

330

470

680

1K

1.5K

2.2K

.26

.29

.32

.34

.38

.48

.50

.61

RESISTORS .02 ea!

2.7K

3.3K

3.9K

4.7K

6.8K

10K

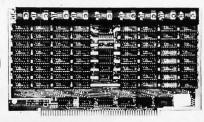
12K

15K

(100 PACK) 1/4W

* 9 Regulators





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	5	.92
COMM	6	.95
TO UNIT	7	.99
	8	1.05
	9	1.15

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est prices you can

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few pennies for the

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47K

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100K

150K

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HOBBIEST

LM323K

REGULATOR

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7805	+5V 1A
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HEAT SINKS 49¢

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S-100-CONNECTOR

TI or Better



SOLDER TAIL

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18K 20K WIRE WRAP WIRE

Packed in 500 Lot Bundles (Length includes 2" x 1" Strip)

Color - R, Bu, G, Y, Bk, W

50 ft, \$1.65 - 100 ft, \$3.00 - 500 ft, \$9.50 2.5-3.25 4.0-3.75 6.0 - 4.757.0-5.00 3.0 - 3.354.5 - 4.003.5 - 3.505.0 - 4.508.0 - 5.50

OK WIRE WRAP TOOL \$5.95





6 Amps 125 VAC 7 Amps 30 VDC

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14DP	14	.55
16DP	16	.58
24DP	24	.95
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Socket and Dip Plug priced based on gold not exceeding \$700 per ounce

CONNECTORS

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PINS	PRICE	PINS	PRICE	
20	2.35	20	3.35	
26	3.00	26	3.80	
34	3.85	34	4.65	
40	4.50	40	5.50	
50	5.50	50	5.90	

RIBBON - 20 to 34 @ 1.00 ft. 40 & 50 @ 1.30 ft.

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4MHZ Beastie with extra instructions!

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	74LS01	.33	74LS109	.59	74LS240	2.95
	74LS02	.33	74LS112	.59	74LS241	2.49
	74LS02	.33	74LS112	40000000	74LS241	
				.59		1.95
	74LS04	.59	74LS114	.49	74LS243	1.95
	74LS05	.39	74LS122	.59	74LS244	2.95
	74LS06	.39	74LS123	1.19	74LS245	8.95
	74LS07	.39	74LS124	1.49	74LS247	1.19
	74LS08	.59	74LS125	.89	74LS248	1.19
	74LS09	.39	74LS126	.89	74LS249	1.69
	74LS10	.29	74LS132	.79	74LS251	1.79
	74LS11	.39	74LS133	1.19	74LS253	.95
	74LS12	.39	74LS136	.69	74LS257	1.95
	74LS13	.69	74LS138	.99	74LS258	1.95
	74LS14	1.25	74LS139	.99	74LS259	2.95
	74LS15	.49	74LS145	1.25	74LS260	.75
	74LS20	1.95	74LS148	1.49	74LS266	1.15
	74LS21	3.7	74LS148	.79	74LS200	1.75
	74LS22	.29	74LS154	2.49	74LS275	4.39
	74LS26	.39	74LS155	1.49	74LS279	.79
	74LS27	.49	74LS156	1.49	74LS283	1.49
	74LS28	.39	74LS157	1.49	74LS289	5.75
	74LS30	.49	74LS158	1.49	74LS290	1.29
	74LS32	.95	74LS160	.75	74LS293	1.95
	74LS33	1.95	74LS161	1.99	74LS295	1.95
	74LS37	.75	74LS162	1.25	74LS298	1,29
	74LS38	.39	74LS163	1.25	74LS324	1.75
	74LS40	.25	74LS164	2.15	74LS352	1.65
	74LS42	1.39	74LS165	1.49	74LS353	1.65
	74LS47	.79	74LS166	2.49	74LS365	.95
	74LS48	.79	74LS168	2.95	74LS366	.79
	74LS35	.25	74LS169	1.95	74LS367	.99
	74LS54	.25	74LS103	1.95	74LS368	.99
	74LS55	.70	74LS173	1,25	74LS373	2.95
	74LS33	.79	74LS173	1.49	74LS373	3.95
	74LS74	.59	74LS175	1.49	74LS377	1.95
	74LS75	.79	74LS181	2.15	74LS378	1.95
	74LS76	.79	74LS189	6.95	74LS379	1.95
	74LS78	.49	74LS190	.99	74LS386	.59
	74LS83	.95	74LS191	1.95	74LS390	1.95
	74LS85	1.49	74LS192	1.95	74LS393	1.95
	74LS86	.95	74LS193	1.95	74LS395	1.95
	74LS90	.75	74LS194	1.49	74LS490	4.95
	74LS92	.75	74LS195	.95	74LS668	1.69
	74LS93	.95	74LS196	.95	74LS669	1.89
	74LS95	1.29	74LS197	1.95	74LS670	3.55
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SH	IUGART -	SIEMANS -	CDC 8"	
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+5V @ 2A	-5V @ .5A	+24V @ 3A	US-206	69.00
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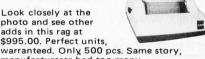
Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.



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photo and see other adds in this rag at \$995.00. Perfect units, manufacturerer had too many.



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Double Density 8" and 5" Disk Controller disigned for S-100 IEEE standards. Uses Western Digital 1795 1691 2143 Chip Set.



FANS \$14.95

These are brand new, in the box fans. Not noisey bearing pullouts. Never again at these low prices!



4-5/8"

4116s

Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer. \$2.95 200 NS

DIP-80 \$399.00

SPECIALS OF THE MONTH

Don't be mislead by this LOW price. This is a rug-ged 100% Duty Cycle 7 by 7 Dot Matrix Printer. Brand new, factory warr.



• RS-232 ADD \$65.00 • TRACTOR FEED ADD \$70.00

2114s

One of the world's two most popular STATIC RAMs. Factory prime

200 NS tested units. Sold in lots of 8 only. FUJITSU, HITACHI, etc.

TMS-4044 MM-5257 **INTEL 2147** \$4.25 250 NS

The other of the world's most popular STATIC RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

2716s 2708s \$9.50 (450 NS) 2708s \$6.95 (450 NS)

Remember when 2716s were \$50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed!

SHUGART DRIVE 8" 801R

Manufacturer had too many, buys at \$395.00

8" 851R \$585.00 1000 piece rate, sales dropped, so we got'em. Fantastic buy, get

them while they last! Full warranty.

SIEMANS DRIVE

8" 120-8

\$375.00

Very Special Price on these BRAND NEW current production units Add \$10.00 for Extended 1 Year Warrantee!

ALESALESALE

Disk Drives



JADE's new dual disk sub-assemblies include: Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power supply, cooling fan, cable kit, lighted power switch, approved fuse assembly, line cord, Never-Mar rubber feet, and all necessary hardware to mount 2-8" disk drives - it's all American made. guaranteed for six months, and it's in stock! Dual 8" Sub-Assembly Cabinet

Single sided, double density disk drive sub-system END-000423 Kit w/2 8" drives \$975.00 END-000424 A & T w/2 8" drives \$1195.00

Double sided, double density disk drive sub-system END-000426 kit w/2 8" drives \$1495.00 END-000427 A & T w/2 8" drives \$1695.00

JADE DISK PACKAGE

Double density controller, two 8" double density floppy disk drives, CP/M2.2 (configured for controller), hardware and software manuals, boot PROM, cabinet, power supply,

Special package price \$1395.00

8" Disk Drive Sale

Highly reliable double density floppy disk drives Shugart 801R single sided, double density MSF-10801R SA-801R \$425.00 Special Sale Price 2 for \$790.00

Siemens FDD100-8D2 single sided, double density MSF-201120 6 mo warranty \$385.00 Special sale price 2 for \$750.00

Real Double-Sided Drives 8" Double-Sided Double-Density Sale ********

* Shugart SA-851R double-sided, double-density * * only \$625.00 ea 2 for \$1190.00 * *******

MFE M701 8" double-sided, double-density drives only \$525 ea 2 for \$1040.00

Qume Data Track 8 double-sided, double-density drives only \$575.00 2 for \$1100.00

Printers

CENTRONICS 737-1

9 x N dot matrix, letter quality, proportional spacing PRM-15737 Parallel \$795.00 With interface for Apple \$895.00

MX-80 - Epson

132 column, 9 x 9 dot matrix, multiple fonts PRM-27080 Save \$100.00 \$545.00 Interface for Apple \$110.00



SPINWRITER - NEC

65 cps, bi-directional, letter quality printer with deluxe tractor mechanism, both parallel and serial interfaces onboard, 16K buffer, ribbon, print thimble, graphics, micro space justification, data cable, and self test/diagnostic ROM

PRD-55511 without 16K buffer ... \$2795.00 PRD-55512 with 16K buffer \$2895.00

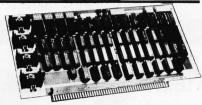
S-100 Systems

S-100 SYSTEM - Calif Computer Sys

Complete S-100 system including 12 slot mainframe, 4 MHz Z-80 CPU, 64K RAM memory, double density disk controller, RS-232 cable, 8" & 51/4" disk drive cables, CP/M 2.2, manuals, auto boot ROM, completely assembled & tested.

2210A Integrated & tested \$1995.00 2210B Not integrated \$1795.00

S-100 Memory



64K RAM - Calif Computer Sys

4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable, PHANTOM line allows memory overlay, 8080 / Z-80 / front panel compatible. MEM-64565A A & T \$449.95

MEMORY BANK - Jade

4 MHz, IEEE S-100, bank selectable, 8 or 16 bit MEM-99730B Bare board \$55.00

 MEM-99730B
 Sate board
 \$35.00

 MEM-99730K
 Kit, no RAM
 \$219.95

 MEM-16730K
 16K kit
 \$249.95

 MEM-32731K
 32K kit
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 MEM-48732K
 48K kit
 \$324.95

 MEM-64733K
 64K kit
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4 MHz RAM board expandable from 16K to 256K MEM-16630K 16K kit \$275.95 MEM-32631K 32K kit \$295.95 MEM-64633K 64K kit \$335.95 Assembled & tested add \$50.00

32K STATIC RAM - Jade

2 or 4 MHz expandable static RAM board uses 2114L's MEM-16151K 16K 4 MHz kit \$169.95 MEM-32151K 32K 4 MHz kit \$299.95 Assembied & tested add \$50.00

16K STATIC RAM - Cal Comp Sys

2 or 4 MHz 16K static RAM board, IEEE S-100, bank selectable, Phantom capability, addressable in 4K blocks MEM-16160A 16K 2 MHz A & T ... \$286.95 MEM-16162A 16K 4 MHz A & T ... \$289.95 MEM-16160B Bare board \$50.00

PB-1 - S.S.M.

2708, 2716 EPROM board with built-in programmer MEM-99510K Kit \$154.95 MEM-99510A A & T \$229.95

PROM-100 - SD Systems

2708, 2716, 2732, 2758, & 2516 EPROM programmer MEM-99520K Kit \$219.95 MEM-99520A Jade A & T \$269.95

S-100 Video

VB-3 - S.S.M.

80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board

IOV-1095K	4 MHz kit	\$375.00
IOV-1095A	4 MHz A & T	\$450.00
IOV-1096K	80 x 48 upgrade	\$39.95

VIDEO BOARD - Jade

64 characters x 16 lines, 7 x 9 dot matrix, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100,

IOV-1050K	Kit		 	\$99.95
IOV-1050A	A & T		 8	\$125.00
IOV-1050B	Bare bo	ard	 	\$19.95

S-100 CPU

2810 Z-80* CPU - Cal Comp Sys

2/4 MHz Z-80A* CPU with RS-232C serial I/O port and onboard MOSS 2.2 monitor PROM, front panel compatible. CPU-30400A A & T \$269.95



THE BIG Z* - Jade

2 or 4 MHz switchable Z-80* CPU with serial I/O, accomodates 2708, 2716, or 2732 EPROM, baud rates from

CPU-30201K	Kit	\$145.00
CPU-30201A	A & T	\$199.00
CPU-30200B	Bare board	. \$35.00

CB-2 Z-80 CPU - S.S.M.

2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.

CPU-30300A A & T \$229.95

SBC-200 - SD Systems

4 MHz Z-80* CPU with serial & parallel I/O ports, up to 8K of on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.

S-100 Disk Controller

DOUBLE DENSITY - Cal Comp Sys

5½" and 8" disk controller, single or double density, with on-board boot loader ROM, and free CP/M 2.2* and

IOD-1300A A & T \$369.95

DOUBLE-D - Jade

Double density controller with the inside track, on-board Z-80A*, printer port, IEEE S-100, can function on an interrupt driven buss

IOD-1200K	Kit	\$299.95
IOD-1200A	8" A & T	\$389.95
IOD-1205A	51/4" A & T	\$389.95
IOD-1200B	Bare board	. \$65.00

VERSAFLOPPY II - SD Systems

New double density controller for both 8" & 51/4"

 IOD-1160K
 Kit
 \$379.95

 IOD-1160A
 Jade A & T
 \$439.95

Motherboards

ISO-BUS - Jade

Silent, simple, and on sale - a better motherboard

6 Slot (51/4" x 81/8") MBS-061B Bare board \$19.95 MBS-121B Bare board \$29.95

MBS-121K Kit \$69.95 MBS-121A A & T \$89.95 18 Slot (14½" x 8¾") MBS-181B Bare board \$49.95

Card Cages

S-100 CARD CAGE - Jade

Metal cage with card guides & fan mounting ENX-106001 Six slot \$29.95

S-100 CARD CAGE - Vector 19" rack mountable, adjustable, holds 21 cards VCT-CCK100 Anodized Al \$49.95

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	card with 2 SIO's, 4 CTC's, and 1 PIO
	2 CTC's, 1 SIO, 1 PIO \$199.00
	<i>A & T</i> \$259.00
IOI-1046K	4 CTC's, 2 SIO's, 1 PIO \$259.00
IOI-1046A	A & T \$319.00
IOI-1045B	Bare board w/ manual \$59.95
IOI-1045D	Manual only \$20.00
	I/O-4 - S.S.M.
2 serial	I/O ports plus 2 parallel I/O ports

2 serial	I/O ports plus 2 parallel I/O p	orts
IOI-1010K	Kit	\$179.95
IOI-1010A	A & T	\$249.95
IOI-1010B	Bare board	. \$35.00

TERMINATOR - S.S.M.

Active te	rminator for 5-100 ous	
TSX-195K Kit .		\$29.95
TSX-195A A & 7	T	\$54.95
TSX-195B Bare	board	\$22.95

S-100 EXTENDER - Cal Comp Sys

from one of ou			
TSX-160A	A & T	 	\$37.95

S-100 PROTO BOARD - Jade

Universal	design,	plated	thru	holes,	gold	fingers
TSX-140B	Bare b	oard				\$24.95

TERMINATOR & EXTENDER - C.C.S.

Can be used	as both	an S-100	extender and	terminator
TSX-150K	Kit .			\$43.95

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DISKETTES - Jade

Bargain prices on magnificent magnetic media

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MMD-5111003	10 sector \$	27.95
MMD-5111603	16 sector \$	27.95

MMD-5220103 Soft sector \$39.95 8" single sided, single density, box of 10

MMD-8110103 Soft sector \$33.95 8" single sided, double density, box of 10

MMD-8120103 Soft sector \$39.95 8" double sided, double density, box of 10 MMD-8220103 Soft sector \$49.95

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High quality, high resolution video monitor VDM-750900 9" monitor \$159.95

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The hi res color you've been promising yourself VDC-201301 \$449.00

12" GREEN SCREEN - NEC

20 MHz, P31 phosphor video monitor with audio, exceptionally high resolution - A fantastic monitor at a very reasonable price

VDM-651200 12" monitor \$259.95

Mainframes

MAINFRAME - Cal Comp Sys

12 slot S-100 m	ainfra	me with 20 amp powe	r supply
ENC-112105	Kit		\$359.95
ENC-112106	A &	T	\$419.95

DISK MAINFRAME - NNC

Holds 2 8" drives and an 8 slot S-100 system. Attractive metal cabinet with 8 slot motherboard, power supply, fan, key switch, and other professional features ENS-112320 with 30 amp p.s. \$699.95

Accessories-Apple/TRS-80



16K MEMORY UPGRADE

Add 16K of RAM to your TRS-80, Apple, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper

otocks, joot-proof t	nstructions, and our 1 year guarantee.
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51/1" disk dri	ve with controller for	or your	Apple
MSM-12310C	with controller		\$499.95
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DISK DRIVES for TRS-80

23% more storage, 8 times faster, 40 track with free patch, 120 day warranty, includes case, power supply, and cable MSM-12410C Save \$125.00 !!! \$299.95

DOS 3.3 UPGRADE - Apple

Ungrade	your old DOS to	the improved	
IOD-2233A	· Control of the control of the control of the	PERSONAL PROPERTY OF THE PROPERTY OF THE PERSON OF THE PER	

APPLE STICK - Micromate

		-			TITLE CITIE	
	Joy	stick	with	pots	for Apple II	
SYA-151	0A	A &	T .			. \$35.95

Z-80* CARD for APPLE

Z-80* CPU card with CP/M 2.2 for your Apple CPX-30800A A & T \$279.95

AIO - S.S.M.

Paralle	el & serial interface for your Ap	ple
DI-2050K	Kit	\$155.95
1-2050A	1 & T	\$194 95

PRINTER INTERFACE - C.C.S.

Centronics type I/O card w/ firmware IOI-2041A A & T \$99.95

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Real	time clock w/battery b	back-up
OK-2100A	A & T	\$109.95

Modems

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A real star! 300 baud, answer/originate, RS 232C

NOVATION CAT

300 baud, answer/originate acoustic modem		
IOM-5200A	1 year warranty	\$179.00

D-CAT	300 baud, direct connect	modem
IOM-5201A	Special sale price	\$189.00

AUTO-CAT Auto answer/origiate, direct connect IOM-5230A Special sale price \$239.95

MICROMODEM - D.C. Hayes

١	Auto answe	r/dial modem car	d for Apple	or S-100
1	IOM-2010A	Apple modem		\$349.95
١	IOM-1100A	S-100 modem		\$375.00

MICRONET MODEM - Micromate

Direct connect with extra features - a best buy IOM-2020A Best Apple modem \$275.00

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Single Board Computers



AIM-65 - Rockwell

6502 computer with alphanumeric display, printer, &
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CPK-50165 1K AIM \$374.95
CPK-50465 4K AIM \$449.95
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SFK-64600004E 4K assembler ROM \$84.95
PSX-030A Power supply \$64.95
ENX-000002 Enclosure \$49.95

4K AIM, 8K BASIC, power supply, & enclosure Special package price \$625.00

Z-80* STARTER KIT - SD Systems

Complete Z-80* computer with RAM, ROM, I/O, display, keyboard, manual, and kluge area.

MICROPROCESSORS	PROMS
Z-80 10.95	2708 450ns 6.25
Z-80A 12.95	10 for \$4.90 ea
6502 11.50	2716 12.5v 11.95
6800 11.95	2716 5v 11.95
6802 17.95	10 for \$8.90 ea
6809 39.95	2532 5v 39.95
8035 24.00	2732 5v 39.95
8080A 6.59	2758 5v 9.95
8085 15.95	
8748 59.95	RAMS
Z-80 SUPPORT	21L02 2 MHz 1.25
3881 PIO 9.50	21L02A 4 MHz 1.50
3881-4 PIO-4 MHz . 14.50	2114L 2 MHz 3.75
3882 CTC 9.50	2114LA 4 MHz 3.95
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74S51 .50 74S168 1.59 74S51 .50 74S168 1.59 74S51 .50 74S164 1.55 74S65 .50 74S168 1.55 74S74 .79 74S240 2.55 74S16 .79 74S240 2.55 74S112 .79 74S241 2.55 74S113 .79 74S242 3.25 74S114 .79 74S243 3.25 **LIMITED AVAILABILITY ON T	74S473* 19.95 74S474* 21.95 74S475* 21.95 74S570* 7.95 74S571* 7.95 74S573* 19.95 74S573* 19.95 74S940 3.15 74S941 3.15	1	LM331N 3.95 NE531H 3.95 RC4194TK 5.95 LM334Z 1.30 NE536H 6.00 RC4195TK 5.49
CA3023H 3.25 CA3023H 1.35 CA3039H 1.35 CA3046N 1.30 CA3059N 3.25 CA3081N 2.00 CA3050N 3.25 CA3082N 2.00 CA3080H 1.25 CA3086N .85	CA3089N 3.75 CA3096N 3.95 CA3130H 1.39 CA3140H 1.25 CA3160H 1.25 CA3401N .59 CA3600N 3.50	1/4 WATT RESISTOR ASSORTMENTS - 5% ASST. 1 5ea. 10 Ohm 12 Ohm 15 Ohm 15 Ohm 27 Ohm 30 Ohm 12 Ohm 15 Ohm 50	CAPACITOR CORNER 50 VOLT CERAMIC DISC CAPACITORS Value 1-9 10-99 100+ 10 pf 0.8 0.6 0.5 0.001
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Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete – just add switches and lens.

MA1003 Module\$16.95

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9.95



2 National Semiconductor

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MM5290N-4 (MK4116/UPD416) . . \$4.95 each 16K DYNAMIC RAM (250NS) (8 EACH \$39.95) (100 EACH \$450.00/lot)

MM5290J-2 (MK4116/UPD416) . . \$6.95 each 16K DYNAMIC RAM (150NS) (8 EACH \$49.95) (100 EACH \$550.00/lot)

MM2114-3 \$5.95 each 4K STATIC RAM (300NS) (8 EACH \$43.95) (100 EACH \$450.00/lot)

EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.

 Maintains constant exposure distance of one inch.

 Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure Compact only 7-5/8" x 2-7/8" x 2" Complete with holding tray for 4 chips.

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Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht.
- Uses MM5314 clock chip
- · Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
 Simulated walnut case
- 115VAC operation

- 12 or 24 hour operation
 Includes all components, case and wall transformer
 Size: 6¾" x 3-1/8" x 1¾" JE747 \$29.95

6-Digit Clock Kit

- Bright .300 ht. comm. cath ode display
 Uses MM5314 clock chip

- Uses MM5314 clock chip
 Switches for hours, minutes
 and hold modes
 Hrs. easily viewable to 20 ft.
 Simulated walnut case
 115 VAC operation
 12 or 24 hr. operation
 Incl. all components, case &
 wall transformer
 Size: 58*V 3-1/8" x 1%"

JE701.....\$19.95

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power upply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

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National Semiconductor Clock Modules MICROPROCESSOR COMPONENTS

INS8080A	CPU	- (
DP8212	8-Bit Input/Output	:
DP8214	Priority Interrupt Control	
DP8216	Bi-Directional Bus Driver	
DP8224	Clock Generator/Driver	- 1
DP8226	Bus Driver	:
DP8228	System Controller/Bus Driver	- 4
DP8238	System Controller	
INS8243	I/O Expander for 48 Series	9
INS8250	Asynchronous Comm. Element	16
DP8251	Prog. Comm. I/O (USART)	
DP8253	Prog. Interval Timer	1
DP8255	Prog. Peripheral I/O (PPI)	1
DP8257	Prog. DMA Control	1
DP8259	Prog. Interrupt Control	1
DP8275	Prog. CRT Controller	45
DP8279	Prog. Keyboard/Display Interface	19
DP8300	Octal Bus Receiver	6
DP8303	System Timing Element	
DP8304	8-Bit Bi-Directional Receiver	
DP8307	8-Bit Bi-Directional Receiver	1
DP8308	8-Bit Bi-Directional Receiver	:

0/6800 SUPPORT DEVILES - MPU
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Peripheral Inter. Adapt (MC620)
1284-5 bit ROM (MC6A26)
1284-6 bit ROM (MC6A26)
12 14.95 19.95 4.95 7.49 10.96 14.95 6.95 6.95 10.95 12.95 2.25

Guad-State Blux, Trans, (MGBT%)
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CPU (MKBB0N) (2MH2)
CPU (MKBB0N-) (2MH2)
CPU
CPU
MPU—881 Silce (Com. Temp. Grade)
MPU-W/Clock (66K Bytes Memory)
MPU-Bill (6MH2)
CPU (MBB0N-BH) (18bytes RAM)
CPU 48 Bytes RAM)
CPU 48 Bytes RAM)
CPU 48 Bytes RAM)
CPU 48 Bytes RAM) Z80 (780C) Z80A (780-1) CDP1802

CPU-16-Bit
MPU-16-Bit
MPU-16-Bit
Doul 25-Bit Dynamic
Dual 25-Bit Dynamic
Dual 25-Bit Dynamic
Dual 25-Bit Dynamic
Dual 25-Bit Dynamic
MPU-16-Bit
Dual 25-Bit Dynamic
Dual 25-Bit Dynamic
Dual 25-Bit Dynamic
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Fife (Dual 80)

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SK BAUD UART

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2117 4116 (UPD416) MM2147) 5101 5101 MM5261 MM5262 MM5280,7:2(4116) MM5283-3-A 7489 UPD414/MK4027 TMS4044-45NL TMS4045

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8K EPROM

8K EPROM

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16K EPROM (60, +5V)

2K EPROM

9K EPROM

9K EPROM

204 PROM

204 PROM

204 PROM

204 PROM

204 PROM

EVENT PROM

204 PROM

EVENT PROM

EVEN PROM

EVENT PROM

EVENT PROM

EVENT PROM

EVENT PROM

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EVENT PROM

EVEN PROM

EVENT PROM

EVENT PROM

EVENT PROM

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EVENT PROM

EVENT PROM

EVEN PROM

EVENT PROM

EVEN PROM

EVE 2708 TMS2716 2716 intel (2516) T i 2732 intel (2532) T i 2758 5203 82523 (745188) 825115 825123 (745288) 825185

ROM'S

Character Generator (Upper Case)
Character Generator (Lower Case)
Character Generator
2048-Bit Read Only Memory

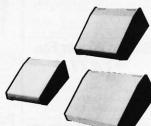
NMOS READ ONLY MEMORIES MCM66710P MCM66740P MCM66750P 128×9×7 ASCII Shifted w/Greek 128×9×7 Math Symbol & Pictures 128×9×7 Alpha, Control Char. Gen. 13.50 13.50 13.50 OPROCESSOR MANUALS M-Z80 M-CDP1802 M-2650

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16k memory (8) 4116's

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The system is comprised of a premium cast aluminium and fiberglass enclosure, along with a Honeywell / Microswitch hall effect keyboard. Thirty display lamps advise the operator of the systems status. Four inch load speaker acknowledges acceptance of data and alerts the operator of pending problems. But most of all this "USED" terminal, with a little imagination, can be engineered to make the perfect home for an S-100 computer and video display; or with slight modification will accept the Rockwell AlM-55 micro/computer.

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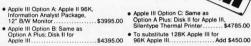
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100% CERTIFIED ERROR-FREE!

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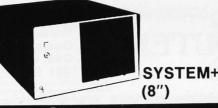
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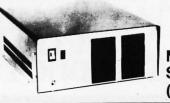
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The QT System+ is designed for both businessmen and engineers in accordance with the latest IEEE standards. Among other functions, it can be used for accounting and word processing, as well as a variety of scientific applications. The system will soon be available with MP/M® to allow multiuser, multi-tasking operations. This means, for example, that an engineer could be working on scientific applications in the lab while an accountant is writing payroll checks in the office. QT also offers a full line of business

and applications software, ranging from a business package to word processing.

Technical specifications: 4MHz Z-80A CPU • Dbl-sided, dbl-den. 51/4" & 8" floppy disk controller (handles both drives simultaneously) • Two 8" dbl-den., sgl. or dual sided disk drives, expandable to 4 floppy drives • CP/M® 2.2 included • 64K RAM • Comes complete in single mainframe • EPROM/ROM in any combination to 8K .

Two RS232C serial I/O ports • Two parallel I/O ports • Hard disk compatible • Real time clock • Std. 2K monitor program & disk routines included on ROM . Poweron/Reset jump to monitor program • 2716 (5V) EPROM programmer (software incl. on monitor ROM)(ext. 25.5V @ 50ma req.) • Uses Z-80A CPU vectored interrupts . Assembled, tested & burned . Documentation included.

With Terminal 920C Add \$900.00

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DDC-88-4 Cabinet only \$ 75.00

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SDS-PROM-100K kit\$220.00
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Bare Board \$35.00 each 10 for \$300.00

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2513 .

SBC+2/4 SINGLE BOARD COMPUTER

Features: 1K RAM (which can be located at any 1K boundary) plus one each Parallel and Serial I/O parts on board • Power on jump to on-board EPROM (2708 or 2716) • EPROM addressable on any 1K or 2K boundary • Full 64K use of RAM allowed in shadow mode . Programmable Baud rate selection, 110-9600 • 2 or 4MHz switch selectable • DMA capability allows MWRT signal generation on CPU board or elsewhere in system under DMA logic or front panel control . Two programmable timers available for use by programs run with the SBC+2/4 (timer output and controls available at parallel I/O connector; parallel input and output ports available for use on CPU board).

 Bare Board
 \$ 60.00

 Kit
 \$190.00

 A&T
 \$295.00

Z+80 CPU

Features: Power on jump to on-board EPROM (2708, 2716 or 2732) • EPROM addressed on any 1K or 2K boundary; also shadow mode allows full 64K use of RAM • On-board USART for Synchronous or Asynchronous RS-232 Operation (Serial I/O port) • Programmable Baud rate selection, 110-9600 • Switch selectable 2 or 4 MHz • MWRITE signal generated if used without front panel • Front panel compatible.

Bare Board	 \$ 50.00
Kit	 \$150.00
A&T	 \$210.00

RAM+16

Features: S-100, 16K x 8 bit static RAM • 2 or 4 • MHz • Uses 2114 1K x 4 static RAM chip • 4K step addressable • 1K increment memory protection, from bottom board address up or top down • Deactivates up to six 1K board segments to create "holes" for other devices • DIP switch selectable wait states • Phantom line DIP switch • Eight bank select lines expandable to ½ million byte system • Data, address and control lines all input buffered • Ignores I/O commands at board address.

Bare Board													\$ 35.00
4Mhz Kit													\$190.00
4Mhz A&T													\$225.00

RAM+ 65

•S-100, 16K x 8 bit static RAM •2 or 4MHz
•Uses 2114L (300NS) CHIP •Addressable in 4K
steps •Memory protection in 1K increments,
from bottom board address up or top down •
May deactivate up to six 1K segments of board
to create "holes" for other devices • DIP switch
selectable wait states • Phantom line DIP
switch •Features bank selection by I/O
instruction using any one of 256 DIP, switchselectable codes—allows up to 256 softwarecontrolled memory banks.

Bare Board													\$	35	5.0	0
4MHz Kit													\$2	10	0.0	0
4MHz A&T													\$2	50	0.0	0

COMPUTER SYSTEMS INC.

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QT PRODUCTS

Features: Runs at 4MHz • 3242 refresh controller with delay line • Four layer PC board insures quiet operation • Supports 16K, 32K, 48K or 64K of memory • 24 IEEE-specified address lines • Optional M1 wait state allows error free operation with faster processors • Optional Phantom disable • Uses Z-80 or onboard refresh signal • Bank on/off signal selected by industry standard I/O port 40 (Hex) • Convenient DIP switch selection of data bus bits determines bank in use • 3 watts low power consumption • Convenient LED indication of bank in use.

Definitely works with Cromemco and North Star

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16K \$280.00	32K \$450.00
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Kit																			\$2	20	0.0	00	
A&T																			\$3	37	5.0	00	

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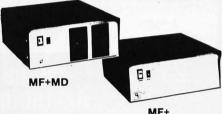
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Includes cabinet, 25 amp power supply, IEEE S-100 compatible 6, 8 or 12 slot motherboard and dual



motherboard and dual 8" disk drive with disk drive power supply.

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Accepts one 8" disk drive (Shugart, Remex, PerSci, Siemens, etc.) • Fan cooled, with data cable and AC line filter to eliminate EMI • Operates from 100-125VAC/200-250VAC at 50-60Hz • Disk drive NOT included.

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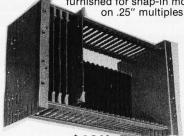
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CND-DA15C	15 PIN COVER	\$ 1.50	\$ 1.30	\$ 1.10
CND-DB25P	25 PIN MALE	\$ 3.50	\$ 3.25	\$ 3.00
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CND-DD50C	50 PIN COVER	\$ 2.00	\$ 1.80	\$ 1.60
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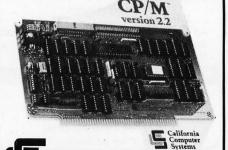
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2 YEAR WARRANTY



The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transpirations exhibiting. ibility and transmission reliability.

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Receiver Sensitivity: —50 dBm ON, —53 dBm OFF
Modulation: Frequency shift keyed (FSK)
Carrier Detect Delay: 1.2 seconds ON; 120 msec OFF
EIA Terminal Interface: Compatible with RS 232
specifications specifications

specifications

- Teletype Interface: 20 milliampere current loop

- Optional Interfaces: IEEE 488; TTL; TTY 43

- International (CCITT) frequencies available

- Switches: Originate/Off/Answer; Full Duplex/Test/Half

Indicators: Transmit Data, Receive Data, Carrier

Indicators: Iransmit Data, necesse Data, Carrier
Power: Supplied by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)
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- 8088 & 8085A CPU
- S-100 IEEE COMPATIBLE

- S-100 IEEE COMPATIBLE
 SWITCHABLE CPU!
 5 MHZ OR 2 MHZ SWITCHABLE
 POWER ON JUMP TO ANY 256 BYTE BOUNDARY
 POWER ON JUMP CAN BE DISABLED
 CPU CAN JUMP ON POWER ON ONLY OR POWER
- ON AND RESET
- 24 BIT EXTENDED ADDRESSING
 IMSAI FRONT PANEL COMPATIBLE
 AVAILABLE WITH 8085A ONLY

BOARD WITH 8085 ONLY

GRT161A

GRT16124

Assembled & Tested \$325.00 \$305.00

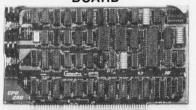
BOARD WITH 8085 & 8088

Assembled & Tested \$425.00

\$399 00

GRT1331

ENHANCED Z80 S-100 CPU BOARD



GBT160 Z80 CPU

- 4-6 MHz Z80 CPU IEEE S-100 Bus Compatible
- On Board Prom Sockets For Up To 8K Prom
- Power On Jump Start To Any 256Byte Boundary On Board Memory Manager For Direct Addressing For Up To 16 M-Bytes
- Fully Maskable Vectored Interrupts

 Waii State Generation For All Machine Cycles

 Bypassing Of All Supply Line To Suppress Transients
- · All IC's Are Socketed

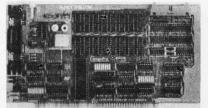
GRT160U

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List Price

Our Pric

\$225.00 \$280.00



SPECTRUM S-100 COLOR GRAPHICS BOARD

Uses the MC6847 LSI IC

GBT144U

- Uses 1372 color encoded/generator
- · Alphanumeric/graphics in 8 colors
- · Ultra dense 256 x 192 full graphics
- 8K bytes, on-board low power RAM
 One full duplex parallel I/O port with attention, enable & strobe bits with power for running joysticks, keyboards, etc
- A parallel port for graphics mode control
- . Board may be used as a 4MHz RAM for program storage

LIST PRICE **OUR PRICE** \$299.00 \$399.00 \$349.00

UNKIT SUBLOGIC UNIVERSAL GRAPHICS GRT20 INTERPRETER SOFTWARE

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INTERFACER I

Our I/O board gives you inparalleled flexibility and operating convenience. We include such features as:

- 2 independently addressable serial ports (dip switch selectable addresses)
- Real LSI Hardware UARTs for minimum CPU housekeeping RS232C, current loop (20mA), & TTL signals on both ports
- · Precision, crystal-controlled Baud rates up to 19.1 KBaud (Individually dip switch selectable)
- Transmit & receive interrupts on both channels, jumperable to any vectored interrupt line
- Industry standard RS232 level converters with five RS232 handshaking lines per port Optically isolated current loop with provisions for both on-
- board & off-board current sources
- LIART parameters interrupt enables & RS232 handshaking lines are software programmable with power-on hardware default to customer specified hard-wired settings for maximum flexibility
- Port connectors mate directly to ribbon cable & DB25 connectors in standard pinouts
- RS232 lines will conform to either master or slave configurations
- . Board gives full feature operation with both 2 & 4 MHz systems
- Low power consumption: +8V @ 450mA: +16V @ 150mA: -16V @ 70mA max
- No software initialization required for board operation, although board parameters may be altered by software OUR PRICE LIST PRICE

\$249.00 GRT133A A&T

IINKIT

INTERFACER II 3PTS

- 1 independently addressable serial port . RS232C; 20mA current loop, & TTL signals
- Precision crystal controlled Baud rate generator
 Up to 19.2K Baud
- Transmit and receive interrupts, jumperable to and vectored interrupt line
- Five RS232 handshaking lines
- Optically isolated current loop
- 3 parallel I/O

GRT150U

- Utilizes LSTTL octal latches for latched I/O data with 24mA drive current
- Enable & strobe bits on each port (each with selectable polarity)
- Interrupts for each input port

UNKIT

· Separate 25 pin connector with power for each channel and a status port for interrupt mask & port status

> LIST PRICE **OUR PRICE**

> > \$199.00

GBT150A \$249 00 \$219.00 ART

ECONOROM 2708

Has provisions for wait states for 4MHz operations. Configured as four 4K blocks—each independently addressable and disabable. Power-on jump. Does NOT include 2708s. Includes all support chips, sockets, regulators, heat sinks, etc. Sold in UNKIT form only. Shipping Weight

GBT125U Unkit



NEW! DISK 1 HIGH PERFORMANCE FLOPPY DISK CONTROLLER

Finally, a floppy disk controller worthy of bearing the CompuPro name is now available for integration into your S-100 system. The DISK 1 floppy controller incorporates numerous features that were previously unavailable on a DMA floppy disk controller board. DISK 1 fully complies with the IEEE 696 bus standard, INCLUDING DMA ARBITRATION!

- Third generation INTEL 8272/NEC 765A LSI floppy disk controller.
- High speed cycle stealing DMA interface for pro-cessor independent data transfer between system memory and flexible disk. Handles up to four 8 or 5.25 inch floppy disk drives.
- Single or double density / single or double sided capability.
 Supports IBM 3740 soft sectored formats.
- 24 bit DMA addressing with data transfer across 64K boundaries for data transfer throughout the 16Mbyte memory man
- I/O mapped interface allows contiguous system memory. (DISK 1 occupies no memory space)
 On board Phantom boot EPROM for automatic
- On board serial port for initial system startup.

 Board compatible with MP/M, OASIS, CP/M-80 and CP/M-86
- Board supplied with BIOS for CP/M-80 CP/M-80 and CP/M-86 available for DISK 1

- CPI/M-80 and CPI/M-86 available for DISK 1. CPU speed independent data transfer for operation up to 10MhZ. Fully arbitrated DMA interface as per IEEE 696 for allowing multiple DMA devices without conflict. May be interrupt driven for multi-user environments. Up to 600K bytes per side (8 inch drive) for an on-line total of up to 4.8M bytes (4 drives double sided adouble density).

LIST PRICE

OUR PRICE

\$199 00

\$219.00

Disk 1 A&T SYSTEM SUPPORT 1

MULTIFUNCTION BOARD

This multi-purpose S-100 board provides your computer with the most needed system support functions at less cost than buying numerous single function boards. Includes sockets for 4K of extended address EPROM or RAM (2716 pinout), 1 socket with battery backup; crystal controlled monthiday/year/time clock with BCD outputs; optional high speed math processor (9511 or 9512); full RS-232 serial port; three 16 bit interval timers (cascade or use independently); two interrupt controllers service 15 levels of interrupts; power fail indicator with provision to switch CMOS memory to battery backup; and comprehensive owner's manual with tery backup; and comprehensive owner's manual with numerous software examples. Conforms fully to all IEEE 696/S-100 standards.

Want to make your S-100 system more versatile? System Support 1 is the answer.

LIST PRICE **OUR PRICE** GRT-16211 \$295.00 A&T Match Clip \$395.00 \$360.00

Static S-100 Memory



32K ECONORAM XX

32K Bank Select. IEEE S-100 compatible. Features one 32K block that can be addressed on 4K boundaries. Compatible with the IEEE proposed standard of 24 address lines as well as all currently used bank select configura-tions. Any or all of the eight 4K byte blocks may be disabled to create as many windows in memory to avoid any system memory conflicts

GBT164A16 16K RAM A & T \$399.00 GBT164A24 24K RAM A & T GBT164A32 32K RAM A & T \$539.00

List Price \$329.00 \$455.00



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*SOCKET and CONNECTOR prices based on GOLD, not exceeding \$700 per oz.

*Sale Prices are for prepaid orders only. Credit card orders will be charged appropriate freight

IMAGINE THE STOI AN 8 INCH FLOPPY

315K BYTES PER SIDE ON 5 1/4" OF COURSE! Micropolis, the worlds largest manufacturer of high density 51/4" disk drives, has been doing it for years. And reliably at that.

An ordinary 5 1/4" floppy provides just 35/tracks per side and stores only 70K bytes. This is not nearly enough for anything useful, so instead, Micropolis uses 77 tracks per side. Each track is then formatted with 16 sectors (hard) at 256 bytes per sector yielding an impressive 315K bytes per side.

Micropolis drives have a larger capacity than many 8'' disk drives, though it only occupies the space of a $5\ 1/4''$ floppy. The 315K byte capacity is roughly 4 times the capacity of a standard $5\ 1/4''$ drive. This is what we call QUAD DENSITY.

To achieve the high density capability, you may think Micropolis had to sacrifice speed or reliability. NOT SO! The track to track access time is only 30ms with a high speed data transfer rate of 250,000 bits per second.

By creating this high density format, Micropolis is able to keep your initial subsystem costs to a minimum. Your cost is less than \$,002 per byte. Thats a BIG VALUE in a small package.

MICROPOLIS disk subsystems are expandable to keep up with your ever increasing needs. Up to four drives/heads may be daisy-chained on one S-100 controller board. With all four drives/heads in operation, you have access to over 12 MEGABYTES of on-line storage.

WITH MICROPOLIS, complete means COMPLETE. Each subsystem comes complete with controller interface, cable, and software. The software includes the MDOS operating system, extended basic, assembler and editor. Everything you need to get "On Line" in one complete package.

MICROPOLIS provides total integration which means they control everything from beginning to end. The result is a better drive for you, backed by a full 120 day factory guarantee.

Anyone can cut price by cutting out capacity or valuable features. But there's no long term advantage in it. Not for the user. Or the builder.

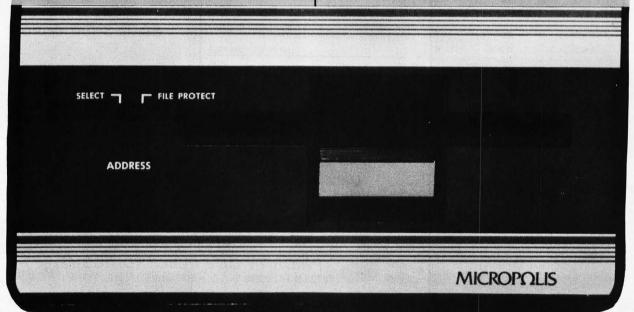
MICROPOLIS takes a better approach, even though it's harder, using advanced design to provide more capability while also lowering cost.

For example, most 5 1/4 inch floppy disks cut costs by using a cheap, less accurate plastic cam or cam follower to position the read/write head. Most 8 inch floppy disks use a better approach, with a rolled steel lead screw for this function.

We go them one better and use an all-steel system, with a precision-ground steel lead screw and steel follower. It costs more but gives us greater storage capacity with lower cost per thousand bytes. Not so incidentally, our steel construction (compared to plastic) significantly increases reliability, too. There's even a built-in File Protect feature that prevents accidental loss of valuable data. (A file protected diskette cannot be written on.)

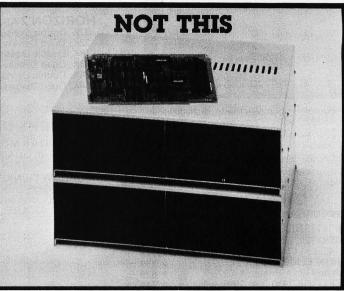
Heat can cause numerous read and write errors that can become hazardous to your data. The major heat producing power supply components are mounted to a large heat sink, external to the cabinet, by the power switch and fuse (located at the rear of the cabinet). This design is to assure that the drive components are kept as cool as possible to assure reliable data recovery.

MICROPOLIS has a reputation for getting along with most everybody. Compatability is not a problem with MICROPOLIS. Their disk drives and/or subsystems can be easily integrated into systems such as Polymorphic, Cromemco, CCS, Ithica Intersystems, Godbout, Northstar, Jade Big Z, QT SBC 2/4, and many others. Many OEM manufacturers rely on MICROPOLIS to get the job done efficiently. Companies like Commodore, Exidy, Harris, and Vector Graphics to name just a few. Years from now, you can look back with a secure feeling knowing you made the best choice, MICROPOLIS.



AGE CAPACITY OF N 5 1/4" FORMAT





Because of our incredible purchasing power, PRIORITY ONE ELECTRONICS is able to buy MICROPOLIS disk drives by the thousands and receive special pricing. That special pricing we receive is passed on to you in the form of tremendously discounted prices. Now all that remains is for you to take advantage of this truly incredible buy.

MODEL	DESCRIPTION	LIST	PRICE
	S-100 SUB-SYST	EMS	
MCP-1053-4	1.2 MB 2 HEAD DUAL	\$2605.00	\$1395.00
MCP-1053-2	630 KB DUAL	\$1895.00	\$995.00
MCP-1043-2	315 KB SINGLE	\$1145.00	\$695.00
MCP-1041-2	315 KB SINGLE, NO PS	\$1045.00	\$639.00
MCP-1042-1	143 KB SINGLE	\$795.00	\$625.00
MCP-1041-1	143 KB SINGLE, NO PS	\$695.00	\$595.00

COMPLETE W/S-100 CONTROLLER, CABLES, MANUALS AND MICROPOLIS MDOS AND BASIC

ADD-ON DRIVES

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MCP-1023-2	315 KB SINGLE	\$645.00	\$495.00
MCP-1021-2	315 KB SINGLE, NO PS	\$545.00	\$475.00
MCP-1022-1	143 KB SINGLE	\$545.00	\$375.00
MCP-1021-1	143 KB SINGLE, NO PS	\$445.00	\$360.00

REQUIRES ACCESSORY ADD-ON CABLES

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We now have a complete line of TRS-80* Model l compatible MICROPOLIS add on drives in matching colors. These drives simply plug into the expansion interface via a disc data cable.

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77 TRACK DUAL	\$1395.00	\$795.00

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NEW DOS/80 TRS-80®

	35 thru 77	SUPPLIED	ON
	TRACK OPERATING	35 TRACK	77 TRACK
	SYSTEM	\$149.00	\$159.00
PR1-34CEEE-2	Two Drive Data Cable		\$29.95
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THIS COULD BE THE START OF SOMETHING SMALL. SEE US AT THE WEST COAST COMPUTER FAIR AND PICK UP YOUR DRIVES.

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Now includes CP/M* 2.2

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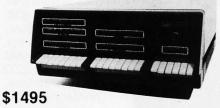
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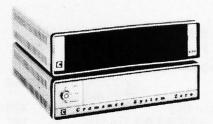
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703 185 cps, bi-direct., tractor, VFU 2395
704 RS232 serial version of 703, \$2350 \$1995

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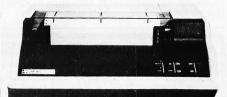
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These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

FOR SALE: Apple Pascal language system. Never used, still in original packing with factory warranty for \$400. M Antonovich, Box 6020, Wyomissing PA 19610.

FOR SALE: Moving, must sell; complete Texas Instruments 9900 minicomputer. Processor board with operating system in prom, 2 K cache programmable memory, 9900 processor, and I/O interface. Memory board with 32 K bytes of programmable memory and complete buffering. Cassette interface and 9600 bps digital cassette player/recorder. Complete system software: Assembler, Linking Loader, Text Editor, Super BASIC, and lots of games. All contained in a fan-cooled chassis. Total price for entire hardware/software computer system is \$1800. Bernard H Penney, 31 Wheeler Dr, Peekskill NY 10566, (914) 945-1044 day/(914) 528-1612 night.

FOR SALE OR TRADE: Kenwood amateur radio equipment: TS520S transceiver, frequency readout, AT200 tuner, 6- and 2-meter transverters, and variable frequency oscillator. All service manuals and cables included. Will sell or trade for Heath H-89 or H-8 computer system. Edward H Hill Sr, 3046 Stuart St, Indianapolis IN 46218, (317) 545-8886.

FOR SALE: PDP-11. DEC PDP-11/05 processor boards with 4 K core memory, 16 to 64 K programmable memory, and parity controller. All working. Also, TI Silent 743 (new) with full ASCII keyboard. Sell all, separately, or trade for line printer or what have you. Make offer. Jack Kreska, 1429 Warwick St, Garland TX 75042, (214) 495-2680.

FOR SALE: Microcomputer magazine collections. BYTE 10/76 (#14) to 12/80 (51 issues) for \$50. Kilobaud Microcomputing 1/77 (#1) to 12/80 (all 48 issues published) for \$70. Interface Age 7/76 (#8) to 8/80 (48 issues plus several original SCCS journals) for \$35. All plus book rate postage. John Cameron, POB 1517, Palo Alto CA 94301, (415) 327-0341.

HELP: I need any information at all about a Compucord 1210 digital cassette tape transport made by Compucord Inc of Waltham, Massachusetts. The company no longer exists, at least in Waltham. Any information regarding this device, the manufacturer, or any source of documentation is eagerly sought. I will be happy to pay for copying, or copy and return all material by return mail. Fred Goldberg, 29 Clearview Rd, E Brunswick NJ 08816, (201) 257-8753.

MUST SELL: One slightly used Cray-1—too big for my apartment. Hardware included: light-dimmer interface, toaster interface, one homebrew 64-bit parallel I/O port with Nixie-tube indicators, coat hangers, extra buffing powder for instruction buffers, one box of bootstraps. Software included: CAL assembler on thirteen cassette tapes in Kansas City format, Morse-code trainer, tic-tactoe game, 8080 emulator. Price is negotiable. A Prilfül, POB 463, Peanutbutter NH 03458.

FOR SALE: TI-59, PC-100A (in perfect working condition), three modules (Master, Statistics, Mathematics and Utilities), eight specialty packettes (Engineering, Science, Securities, Marketing, etc), 20-roll paper for PC-100A, and many finance utility programs. If brand new, you would pay \$640. Now all can be yours if you send a cashier's check for \$460. C M Chen, 120 Columbus PI, Stamford CT 06907, (203) 322-7857.

WANTED: MMD-1 microprocessor trainer in operating condition. Please state asking price in first offer. D C Shoemaker, 2000 A Foxridge, Blacksburg VA 24060, (703) 552-5764.

FOR SALE: 48 K Apple II plus complete with two paddles, some programs, and cassette recorder with interface jack. Only three months old and in great condition. \$1300. Eric Podell, 14949 Wellwood Rd, Silver Spring MD 20904.

FOR SALE: Sold system, must sell software at super reduced prices. Dozens of CP/M, languages, business s/w (G/L, A/R, A/P, etc). Send SASE for complete list and prices. Dee B Moser, Box 638, Great Bend KS 67530.

WANTED: June 1977 and October 1980 issues of BYTE. Will pay cash or trade March 1978, July 1980, August 1980, September 1980 issues. Also, I have for sale a Godbout 8 K S-100 4 MHz programmable memory board, assembled and working; \$50. Thomas Kryst, 5242 E 24th St Apt D, Anchorage AK 99504.



FOR SALE: Speak & Spell with Speak-2-Me-2 installed by Percom Data. 230-word vocabulary plus program to form words from parts of vocabulary words. Complete with modified printer interface cable, user's manual, and driver programs. Set up for TRS-80 Level II with 16 K. Instructions for other computers. Worth \$200, sell for \$150. Joseph Wear, Rt 1 Box 83A, New Egypt NJ 08533, (609) 758-7193.

FOR SALE: Okidata Model CP-110 friction-feed line printer, with RS-232 serial interface and uppercase! lowercase character set. Prints 80 columns bidirectional at 110 cps. Uses 8½-inch roll paper. Excellent condition. Cost \$1349, asking \$650. Virgilio DeCarvalho, Columbia-Princeton Electronic Music Center, 632 W 125th St, Room 318, New York NY 10027, (212) 280-3050.

FOR SALE: H-8, serial I/O board, 20 K programmable memory, cassette, Extended BASIC. Up and running, all documentation included. First \$600 takes. I ship. M H Endres, Box 8, Spirit Lake ID 83869, (208) 623-5911.

FOR SALE: Magic Wand for TRS-80 Model II. Original disk and manual; \$200. A A Schwartz, 6454 Camino Teatro, La Jolla CA 92037.

FOR SALE: Burroughs Series B9352 video terminal. Has printer output, uppercase, and full cursor control. \$300 plus freight. Steve Nelson, Box 150, Webster MN 55088.

FOR SALE: PET 8 K computer with Soundware sound for PET, five tapes with programs including Microchess 2.0, and COMPUTE magazine for the PET. Original PET cost over \$800, will settle for \$675. Also, have ELF II computer complete with documentation and newsletters. Cost over \$200, would like to trade for HP-41C card reader. Am interested in HP-41C equipment, willing to negotiate with PET and ELF II. Shaji Jacob, 827 Lincoln, Fort Morgan CO 80701, (303) 867-8162.

FOR SALE: TI #751 Silent 700 type printer. 10, 15, 30 cps, thermal, Baudot code, receive-only. Complete, but needs electrical work. With five rolls of paper and complete documentation. \$100, you pay shipping, or trade for Heath H-9 terminal. Tom Hamilton, 1405 Washington, Birmingham MI 48009, (313) 647-5420 after 5 PM ET.

FOR SALE: OSI Superboard with expansion, 18 K programmable memory, 8 A power, 9-inch Sanyo monitor, and full enclosure; \$650. 12-slot S-100 motherboard with 15 A power supply and termination; \$150. Microdiversions Screensplitter 46 by 80 video display for S-100, brand new; \$350. Plus much used equipment. Glenn Barnas, 280 Carmita Ave, Rutherford NJ 07070, (201) 935-0271.

FOR SALE: SwTPC CT-64 terminal; \$300 or best. AC-30 cassette interface, works on any 300 bps RS-232 line; 880 or best. MP-A2 6800 processor card with SWTBUG; \$120 or best. All assembled and tested. USR-310 modem; \$130. Keyboard; \$50. Must sell soon. Charles Duff, 7007 N Sheridan #317, Chicago IL 60626, (312) 386-0311 leave message.

FOR SALE: Multiterm printer Model T-4000: 55 cps, Diablo Hytype mechanism, tractor feed, ribbons, print wheels, many additional features, auto-underline, etc. \$1700 or offer. Also, two Centronics 306C printers. \$1200 each or offer. Michael Sloat, POB 982, Loma Linda CA 92354, (714) 796-2757.

FOR SALE: PET owners, I have sixteen 4108 programmable memory circuits guaranteed good. Will sell for \$2.50 each or the entire lot for \$35. Also, if your PET uses 4108s and they are in sockets, and you would like to upgrade to 32 K inexpensively, send \$1 plus SASE for guaranteed instructions. I am also looking for an inexpensive printer with 40/80 lines and Centronics-type parallel input. Harry E Leggans, Box 1179, APO New York 09023.

FOR SALE: Alpha 16 mainframe includes processor, clock/controller, teletypewriter interface, 4 K memory, floppy-disk controller, and power supply. Also, much software and all manuals. \$500 or offer. Edwin Karlow, Department of Physics, Loma Linda University, Riverside CA 92515, (714) 785-2143.

FOR SALE: Siemens FD100 mini floppy-disk drives with manuals, power supplies, and cases. \$250 each or best offer. Western Digital 1771 floppy-disk controller circuits. \$8 each. Marcy Durkee, 10265 Meadowwood Ln, Overland MO 63114.

WANTED: Used computer-science books. Reasonably priced, in good condition; for personal use—only one copy of a title wanted. Examples: programming languages, Knuth (volume 2), programming techniques, compiler design, applications, etc. J R Berman, 494 Forest Ave, Teaneck NJ 07666.

FOR SALE: TRS-80 Model I, Level I, 4 K. Like new, hardly used. \$500. Also, Apple games for trade—Invader, Asteroids, Sargon, etc. Randy Strouth, RR 5 Box 63, Faribault MN 55021, (507) 334-6585.

FOR SALE: Digital Group Z80, Diskmon, Business BASIC, 64-character, 26 K dynamic; \$1200. Two 8-inch disk drives and Digital Group controller; \$1600. Keyboard (needs repair) and 9-inch monitor; \$250. Whole system for \$2800. Wayne Dirks, 801 E 10th, Hutchinson KS 67501, (316) 663-3998 days.

FOR SALE: TRS-80 Model III computer with 48 K programmable memory, brand-new condition. Complete documentation plus several TRS-80 books. \$950. Also, HP-41C programmable calculator with card reader plus blank cards, four memory modules, and MATH and STAT modules. \$500. Alan J Grant, 530 44th St, Brooklyn NY 11220, (212) 436-1714 weekends or after 6 PM weekdays.

FOR SALE: Commodore PET 2001 computer with 8 K programmable memory and new 2.0 read-only memories. Has on-board cassette and small keyboard. \$50 deposit for shipping by UPS collect, balance due of \$475. Dan Rubis, 19713 Alger, St Clair Shores MI 48080, (313) 771-1392.

WANTED: User's manual for Processor Technology 32KRA memory board. Steve Grant, 6055 E Washington Blvd, Suite 1035, Commerce CA 90040, (213) 725-1563.

FOR SALE: Heath H-8, dual-drive H-17, H-9 video terminal, three 8 K programmable memory cards, serial/cassette interface. Entire system for \$1500 or sell in parts. Richard Berhain, 142 Jefferson Ave, Hasbrouck Heights NJ 07604, (201) 288-1693.

FOR SALE: North Star 2 system. Double-density, 48 K, with D C Hayes modem. Two serial and one parallel ports, SOROC IQ 140 terminal, and Centronics 779 tractor printer. Includes \$2000 in business software. Six months old, in original boxes. \$4895 or best offer. Also, D C Hayes modem 100; \$325. Don, (615) 526-7651.

FOR SALE: Heath H-9 terminal; Heath H-10A reader/ punch; TI 9900 single-board 16-bit microcomputer. Complete manuals and software included. Best offer. D Montgomery, Box 27, Oakland FL 32760, (305) 656-4293.

FOR SALE: Super ELF with expansion board, 4 K static programmable memory, two I/O ports, Super Monitor, ASCII keyboard, 4-slot expansion case, power supply, RF modulator, Tiny BASIC cassette, and manuals; \$250. Electric Crayon I/O-driven color graphics unit with 2 K memory, graphics firmware, manual, and built-in RF modulator. Alphanumerics and graphics expandable to 256 by 192. \$200. Brent Elder, 7422 N Campus #7, Cornell University, Ithaca NY 14853, (607) 256-6750.

FOR SALE: Model 33 ASR teletypewriter with manuals, paper-tape reader and punch, and stand. Mint condition, less than 100 hours on usage meter. \$595 plus shipping. Automatic motor control installed and tested is \$30 extra. Ken Brand, 421 Fairview Ave, Winchester VA 22601, (703) 662-0665 after 6 PM.

WANTED: January and May 1979 BYTE. May and June 1978 Creative Computing. January, May, July, and December 1978 Kilobaud Microcomputing. Name your price. Robert Lansdale Jr, 18 Ashfield Dr, Etobicoke Ontario. M9C 4T6 Canada.

January BOMB Results: Hand-Held Computers

Readers responded to our January theme by voting top honors for "The Panasonic and Quasar Hand-Held Computers: Beginning a New Generation of Consumer Computers" by Gregg Williams and Rick Meyer (January 1981 BYTE, page 34). Because Gregg is an employee of BYTE, the \$100 prize will go to Rick.

Steve Ciarcia captured second place for his article "Electromagnetic Interference," page 48 and receives \$50.

Third place wa

Third place was taken by Teri Li for his article "Whose BASIC Does What?" Fourth place went to Michael Keith and C P Kocher for their article "The NEC PC-8001: A New Japanese Personal Computer."

With the January issue, we began to collect votes for the BOMB (BYTE's Ongoing Monitor Box) through responses on one of the reader-service cards. This resulted in an increased number of votes and many favorable comments from readers.

BOMB

BYTE's Ongoing Monitor Box

Article #	Page	Article	Author(s)
1 -	20	Recurrence in Numerical Analysis	Davidson
2	36	Build a Low-Cost Logic Analyzer	Ciarcia
3	46	The MicroAce Computer	Searls
4	66	Digital Minicassette Controller	Kahn
5	94	A Reformatter for CP/M and IBM Floppy	
		Disks	Lehman
6	102	Programming the Game of Go	Millen
7	122	Build Your Own Turing Machine	Willis
8	150	A Closer Look at the TI Speak & Spell	Vernon
9	188	Three Versions of APL	Williams
10	218	An Introduction to Data Compression	Corbin
11	252	Build An Intercomputer Data Link	Wingfield
12	290	Three-Dimensional Computer Graphics,	
		Part 2	Crow
13	348	PADDLES: Interfacing with Modular	Combs and
		Breadboards	Field

Reader Service

Inqui	ry No. Page No.
311 189 293	AB Computers 387 ABM Products 292
56	Abrams Creative 384 Ackerman Digital 82 Action Computer 137 Adaptive Data & Energy Sys 23
18 336 49	Addmaster 392
354 206 108	Advanced Comp Prod 402, 403 Advanced Micro Sys 312 Adventure Int'l 160 ALF Products 78
40	Alpha Byte Storage 59
297 332 308	ALL Electronics 384 Alpha Omega Systems 392 American Busn Comp 386 American Square Comp 273
172 275 276	Ancrona 370, 371 Ancrona 372, 372
218 63 237	Anderson Jacobson 319 Anderson Peripherals 94 Apparat 330
10 198	Apple Computer 13 ASAP 303 ASAP 323
226 202 188	Ashton-Tate 307
156 159	Avocet Sys Inc 294 Axiom 245 BASF 249 Basis Microcomputer GMBH 177 John Ball Engineering 379
285	Basis Microcomputer GMBH 177 John Bell Engineering 379 Beta Comp Devices 315
295 300	Beta Comp Devices 315 BIS Inc 384 Bit Bucket, The 384 BIZCOMP 16
13 82 124	BMC 119
135 152	Bower-Stewart & Assoc 182 BYTE Back Issues 246 BYTE Books 201 BYTE Books 233 BYTE Books 283 BYTE Books 311 Calif Comp Systems 21 Calif Digital 400, 401 Cambridge Learning Inc 333
181 205 17	BYTE Books 283 BYTE Books 311 Calif Comp Systems 21
353 243 93	Calif Digital 400, 401 Cambridge Learning Inc 333
173 143	Cavri Systems 136 Central Data 275 Chrislin Industries 219
301 32 248	Clev Con Comp & Compnts 385 Colonial Data 50 Computer Age Inc 337
210 314 20	Computer Age Inc 337 Computer Case Co 315 Computer City 388 Computer City Canada Inc 25
256	Computer Disc of Am 340 Computer Factory, The 247 Computer Furn & Access 342 Computer Mail Order 278
261 176 104	Computer Mail Order 278 Computer Marketing Corp 152
307 322 57	Computer Marketing Corp 152 Computer Mart Inc 386 Computer Shopper 390 Computer Specialties 84, 85
27 <u>1</u> 51	Computer Specialties 84, 85 Computer Tech Assoc 355 Computer Warehouse 93 Computers R Us 74, 75
342 52 80	Computers Plus Inc 382 CompuMart 76, 77 CompuServe 116, 117
269 183	Computerware 345 Computex 286 COMPUTIME 337
249 45 278	COMPUTIME 337 Compuview Products Inc 67 Concord Comp Components 374
51 107 130	Consumer Computers 74, 75 Corvus Systems 159
130 235	Cover Craft 328 CPM User's Group 60
321 1 118	Cover Craft 328 CPM User's Group 60 CPU Chop, The 389 Cromemco 1, 2 Crystal Computer 173 Custom Business Comp 390 Cyber Innovations 384
323 298	
242 346	Cybernetics Inc 138 Data Access 333 Data Discount Center 146 Data Hardware 382
64 85 178	Datasouth Computer Corp 95 Datasouth Computer Corp 126 Datek 280
84 89	Delta Products 123 Denver Software Co, The 131 Designers Software 167
113 146 266	Diable (Div of Xerox) 223
75 87	Digiac Corp 343 Digicomp 110 Digital Equipmt Corp 241 Digital Graphic Systems 129
141 163 109	Digital Graphic Systems 129 Digital Marketing 213 Digital Pathways 255 Digital Research 161
201 65	Discount Sftw Grn The 306
168 258	DMA 346 Dual System Control Corp 265 Dymarc Ind 341 Dyna Byte C III
361 154	Dyna Byte C III Dynacomp 239

317 252	DWP 388 Ecosoft 339
	Floctravalue Industrial 342
74	Eiron Computers Ltd 108 Efficient Mngmt Sys 327 Electronic Center 380 Electronic Control Tech 28
286	Electronic Center 380
22 339	FIACTIONIC EQUID UNITO 392
270	Flectronic Specialists 345
241 123	Ellis Computing 333 Epson 181 ER Hardins Mitry Madness 329
236	ER Hardins Mitry Madness 329
244 121	Escon 334 Essex Publishing Co 176
227	Essex Publishing 324
36 29	Exatron Inc 55 Eyring Research Inst 45
98	Faircom 144
213 289	Farnsworth Comp Center 317 Fordham Radio Supply 414
225	Forethought 323
25 294	Frederick Comp Prod 32
•	Fredericktowne Comp 384 General Peripherals 388
111 140	Godbout Electronics 163 Godbout Electronics 210, 211 Mark Gordon Computers 104
70	Mark Gordon Computers 104
139	GR Electronics Ltd 208
132 133	H & E Computronics 195 H & E Computronics 197 H & E Computronics 199
134	H & E Computronics 199
291 207	Hanley Engineering 383 Hayden Book Co Inc 313
48	Haves Microcomp Prod Inc 71
31 27	Heath Company 49 High Technology Inc 34
39	Hobbyworld Electronics 58 Horizons Inc 384
299	Horizons Inc 384 Houston Instrument 79
53 54	Houston Instrument 70
15	IMS International 17
190	Innovative Sftw Appl 293
58 59	Integral Data Sys 87
212	IMS International 17 Info Unitd Software 347 Innovative Sftw Appl 293 Integral Data Sys 87 Integral Data Sys 89 Integral Oata Sys 89 Integrand 317 Intelligent Control Sys 341 Intertec Data Systems 53
259	Intelligent Control Sys 341
34 14	Intertec Data Systems 53 Intertec Data Systems 185
345	Intertec Data Systems 53 Intertec Data Systems 185 Introl Corp 382 Ipex Int'l Inc 392
335	Ithaca Intersystems 8
6	Ithaca Intersystems 9
351 352	Ithaca Intersystems 8 Ithaca Intersystems 9 Jade Computer Prod 396, 397 Jameco Electronics 398, 399
230	JDR MICRODEVICES 325
331 283	Jim-pak 391 JR Inventory 378
30	JR Inventory 378 Kern Publishing 48 Key Tronic 153
105 125	Key Fronic 153 Konan Corp 81
341	Lab Microsystems 382
284	Lanier 27 Lax Computer 378
- *	Lax Computer 378 Leading Edge 237 Leapac Services 341
257 310	Leapac Services 341 Leapac Services 386
232	Lee Products Co 31/
88 101	Leo Electronics 130 Lifeboat 141
102	Lifelines 149
325 106	Linmar 390
222	Livermore Data Sys Inc 154 LNW Research 321
99 137	Lobo Drives Int'l 145 Logo Computer Systems 205
305	Lyben Comp 386
348	McHenry & Assoc 382 McMillan Book Club 193
296	Macrotronics Inc 384
319 103	Magnolia Microsystems 388 Malibu Electronics 151
164	Mark of the Unicorn 257 Marot Software Systems Inc 22
144	Manyman Industriae Inc 276
174 77	Mauro Engineering 112
100	Maxell Data 147
	Mauro Engineering 112 Maxell Data 147 Mediamix 388 Meas Sys & Controls 29, 121
221	
228 273	Meta Technologies Corp 358
169	MFJ Enterprising Inc 268
204 38	Micro Age Computer Store 57
199	Meta Research 325 Meta Technologies Corp 358 MFJ Enterprising Inc 268 Micro Ace 309 Micro Age Computer Store 57 Micro Business World 304 Microbuts 308
20 ₀	Micro Comp Discount Co 114
73	Micro Data Base Sys 107

```
Micro Flash 388
Micro Focus 109
Micro House 174
Micro Management Sys 277
Micro Management Sys 277
Micro Mint 392
Micro Pro International 251
Micro Works, The 70
MicroCompEquip 380
Microcomputer Store 340
MicroComptes 51
MicroDaSys 51
MicroDaSys 51
MicroDaSys 51
MicroDaSys 51
MicroDaSys 51
MicroDaSys 51
MicroBast 317
MicRO-SCI 113
MicroSoft (Cons Prod Div) 127
MicroTech Exports 339
Microsoft (Cons Prod Div) 127
MicroTech Exports 339
Microware 322
Mikos 259
Miller Microcomputer Serv 120
Mini Computer Suppliers 339
Mini Computer Suppliers 386
Mini Micro Mart 410
Mini Micro Mart 411
Mini Micro Mart 411
Mini Micro Mart 412
Mini Micro Mart 413
Morrow Designs 73
Mountain Computer Inc 19
Mountain View Press 319
mpi 253
MT Micro SySTEMS 83
312
                                         Micro Flash 388
 153
33
114
214
78
         86
   165
83
255
306
                                         Mountain View Press 319
mpi 253
MT Micro SYSTEMS 83
MTI Inc 271
MTI Inc 300
Multi Business Comp Sys 296
MUSYS 248
   171
 196
192
158
203
182
216
231
                                       Nautilis 246
Nautilis Systems 308
NCC '81 285
NCE Supply Corp 319
NEBS 326
                                       NEBS 326
NEC America Inc 15
NEECO 259
National Computer Show 133
National Multiplex 333
Nestar Systems Inc 299
Netronics 207, 254, 258, 260
Northern Tech Books 183
Ohio Data Products Corp 321
Ohio Scientific Instr C IV
Oliver Advanced Eng 392
Olympic Sales Co 100
Omega Micro Computers 12
Omega Sales Co 156, 157
Omikron 92
Omnibyte 298
           68
9
61
                                         Omikron 92
Omnibyte 298
onComputing 96, 209
Optimal Technology 337
Orange Micro 187
Osborne/McGraw-Hill 139
OSM 263
OSM 390
   127
95
167
   330
                                       OSM 390
Owens Associates 18, 178, 179
Pacific Exchanges 289
Pacific Exchanges 382
Pacific Exchanges 390
Pacific Exchanges 342
Page Digital 381
Palomar Computers 287
Pan American Elec 374
Pan American Airlines 267
Passenort Designs 1347
   327
263
288
   184
277
                                         Passport Designs 134
PCD Systems Inc 6
Percom Data 7
Percom Data 35
         91
           28
   363
364
365
                                           Percom Data 91
Percom Data 91
Percom Data 91
                                 Percom Data 91
Percom Data 91
Percom Data 91
Percom Data 91
Percom Data 91
Percom Data 91
Personal Microcomputers 297
Personal Software 31
Phase One Systems 295
Pickles & Trout 332
Piloeon 115
Power One Inc 171
Priority One 393
Priority One 406, 407
Priority One 408, 409
Professional Comp Store 392
Prometheus 170
P & S Electronics 390
Purchasing Agent, The 288
QT Comp Systems 404, 405
Quality Computer Parts 382
Quality Software 318
Quasar Data Products 215
Qantex 225
Quay 191
Quest 377
R & B Computer Systems 338
 366
367
368
   193
24
191
 239
79
117
 343
 148
```

```
RKS Enterprises 314
Racet Computes 118
Radio Shack 61
Random House 338
RCA Solid State 64
RCA Solid State 189
RNB Enterprises 180
Rochester Data 10
Roland's Song Stfwr 331
S & M Systems 327
S-100 Inc 341
Howard W Sams Co 80
SC Digital 337
Scientific Engineering 190
Scion Corp 5
           43
         55
  129
                                               Scion Corp 5
SciTronics Inc 90
SciTronics Inc 336
Scotia Software 388
  315
                                               Scottsdale Systems 62
SD Systems 169
SKP Electric 386
                                             SKP Electric soo
Sluder 382
Small Business Applications 14
Softech Microsystems 203
Softech Microsystems 316
                                      Small Business Applications 14
Softech Microsystems 203
Softech Microsystems 203
Softech Microsystems 316
Soft Tools 390
Software-To-Go 194
SoHo Group, The 162
Solid State Sales 172
Solid State Sales 172
Solid State Surplus 386
Source EDP 281
Sorrento Valley Assoc 206
Sorrento Valley Assoc 206
Sorrento Feed Prod Corp CII
Spectrum Software 261
SSM 11
Stereo House 278
SubLOGIC 282
Sunny Int'l 376
SuperSoft 155, 216, 217, 224, 320
Super Star Int'l Corp 56
Sybex 143
Synchro Sound 69
Synergetic Solutions 323
Systems Plus 269
SZ Software 392
Tab Books 242, 243
Tarbell Electronics 301
Tarco 226
Tech Sys Consultants (TSC) 105
TecMar Inc 279
Televideo 65
Tercer Medio 343
Texas Comp Sys 339
3G Company 196
3M Company 111
Thunderware 106
TNW Corp 343
Toolsmith, The 390
Trade-A-Computer 386
TransNet 327
TSE/Hardside 166
United Software of Am 124, 125
Urban Software 54
US Micro Sales 375
US Robotics 229
V.A.M.P. 382
VANDATA 335
Vector Electronics 68
Vector Graphics 97
Verbatim 103
  110
  8
176
  224
149
71
177
44
  76
72
265
                                         V.A.M.P. 382
VANDATA 335
Vector Electronics 68
Vector Graphics 97
Verbatim 103
Videx 231
Vista Computer Co 63
Vista Computer Co 69
Volcetek 184
VR Data 88
Western Wares 392
Western Union 24
Westico Inc 164, 165, 342
White Computer 33
Whitesmith's Ltd 99
Wild Hare Comp Sys 30
Wintek Corp 384
Winterhalter & Assoc 325
Worldwide Electronics 390
WW Component Supply Inc 376
XPS Inc 388
Zobex 135
  151
    126
```

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